Transport Canada / Transports Canada

Safety and Security / Sécurité et sûreté

Ottawa, Ontario
K1A 0N8

July 13, 1998

Dear CARs Subscribers,

Re: **Part V - Airworthiness**

Although future publication is anticipated of the *reserved* subparts of Part V, namely 500, 551, 561 and 563, they do not presently exist as part of the *Canadian Aviation Regulations.* However, the information currently remains available in the *Airworthiness Manual* and can be purchased through Canadian Government Publishing {(819) 956-4800}. Further, the current CAR 511 incorporates by reference chapters 511, 513 and 516-549 of the *Airworthiness Manual*. Publication of the new CARs 511 - 551 is anticipated before the end of 1998.

Those who have subscribed to the *reserved* CARs subparts and current subscribers to the *Airworthiness Manual* will automatically receive the new CARs as they become available.

Please refer to the table below for current ordering information:

Chapter	**Catalogue No. - Canadian Gov't. Publishing**	**Chapter**	**Catalogue No. - Canadian Gov't. Publishing**
500	*T51-13-501	535	*T51-13-535
CAR 507	***T51-15-507	537	*T51-13-537
CAR 509	***T51-15-509	541	*T51-13-541
CAR 511	**T51-15-511	549	*T51-13-549
511	*T51-13-511	551	**reserved*
513	*T51-13-513		*- publication anticipated in*
516	*T51-13-516		*1998*
522	*T51-13-522	561	*T51-13-561
523	*T51-13-523	563	*T51-13-563
525	*T51-13-525	CAR 571	***T51-15-571
527	*T51-13-527	CAR 573	***T51-15-573
529	*T51-13-529	CAR 591	***T51-15-591
531	*T51-13-531	CAR 593	***T51-15-593
533	*T51-13-533		

* *Airworthiness Manual*
(Note: CARs associated to these chapters of the Airworthiness Manual will be provided as they become available).

***Chapters 511-551 of the Airworthiness Manual are enabled by the current CAR 511.*

***CARs publication (including associated standards)*

Canada

TP 6197E

Transport Canada Transports Canada

CARs

CANADIAN AVIATION REGULATIONS

PART V - AIRWORTHINESS

AIRWORTHINESS MANUAL CHAPTER 523 - NORMAL, UTILITY, AEROBATIC AND COMMUTER CATEGORY AEROPLANES

Canada

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NOTE

All amendments to the CARs will be indicated by the Coming into Force date, immediately following the amended text.

RECORD OF AMENDMENTS

Number	*Date of Amendment*	*Date Entered*	*Entered by*
2003/1	2003/03/01	Jan.12/04	
2003/1	2003/03/01	"	"
2004/3	2004/12/01	Mar.1/05	
2006/2	2006/12/30	Jan. 30/07	
2008/2	2008/12/30	2012/03/06	
2009/1	2009/06/30	2012/03/06	
2009/2	2009/12/01	2012/03/06	
2010/06/01	2010/06/01	"	
2010/05/27	2010/05/27	"	

Number	*Date of Amendment*	*Date Entered*	*Entered by*

AIRWORTHINESS MANUAL CHAPTER 523 – NORMAL, UTILITY, AEROBATIC AND COMMUTER CATEGORY AEROPLANES

Table Of Contents

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PREAMBLE

General

The content of this chapter is based on *the United States Code of Federal Regulations, Title 14, Chapter 1, Part 23* entitled "*Airworthiness Standards, Normal, Utility, Acrobatic and Commuter Category Aeroplanes*". These United States airworthiness standards have been used and adapted as the model for the Canadian standards supplemented by additional airworthiness requirements based on Canadian experience and required for Canadian aviation purposes.

The FAR numbering system is used. The Canadian standards bear the same number as the FAR equivalent, prefixed by the number "5", as this chapter contains the standards for *Part V of the Canadian Aviation Regulations (CARs)*.

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First Edition **Effective: January 1, 1986**

The standards in this chapter are presented in a two column format with the United States FAR in the left column and the Canadian standards in the right column. Chapters, sub-chapters, sections and subsections numbering and headings are opposite to the equivalent FAR. Where the Canadian standard is identical to the FAR, the words "No Variation" appear; where a variation exists, the affected part of text is printed opposite to the FAR with all changes underlined.

The first edition of this chapter is based on FAR Part 23, up to and including amendment 23-31. In addition to administrative changes (e.g., Administrator = Minister; Part = Chapter) and the deletion of references to operating FARs, the Canadian variations included in this edition are as follows:

Miscellaneous Markings and Placards: use of metric units, Section 523.1557 paragraph (c)(4);

Aeroplane Flight Manual: use of metric units paragraph 523.1581(e) and reference to operating rules, paragraph (f);

Editorial correction to Part 23 as follows: Section 523.145, is corrected to refer to 523.161 paragraph (c)(2) in lieu of (c)(3) and (c)(4), and 523.161 paragraph (d)(1) and (d)(2) were deleted.

In addition, the issue of the following applicable Airworthiness Manual Advisories (AMA) are attached to this chapter:

AMA 500C/1 Aircraft Equipment Incorporating Digital Computer Technology, dated 1 May 1986.

AMA 500C/2 Multipurpose Electronic Flight Deck Display Systems, dated 1 May 1986.

AMA 500C/3 Fire Protection - Ignition Sources, dated 1 May 1986.

AMA 500C/4 Portable Fire Extinguishers For Use In Aircraft, dated 1 May 1986.

AMA 523.1581 Aeroplane Flight Manual, dated 1 May 1986.

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Change 523-1 **Effective: January 1, 1988**

This change incorporates the following amendments to the *United States Code of Federal Regulations*, Title 14, Chapter 1, Part 23, effective in Canada on the dates specified herein:

Amendment 23-32 "*Shoulder Harnesses in Normal, Utility and Acrobatic Category Airplanes*" requires the installation of shoulder harnesses at all seats of normal, utility and acrobatic category aeroplanes with a passenger seating configuration, excluding pilot seats, of nine or less, manufactures one year after the effective date of this amendment (which was 12 December 1985 in the U.S.) effective in Canada January 1, 1987.

Amendment 23-33 "*Standardization of Cockpit controls for Small Airplanes*" revises the airworthiness standards for small aeroplanes to require standardization of aerodynamic, powerplant, fuel systems, and auxiliary cockpit controls. This action to standardize cockpit controls is taken to minimize accidents caused by random location, operation, and arrangement of cockpit controls effective: January 1, 1987

Amendment 23-34 "*Airworthiness Standards and Operating Rules: Commuter Category* Airplanes" adopts certification procedures, airworthiness and noise standards and operating rules for an additional category of propeller-driven, multi-engine aeroplane, designated as the Commuter Category. In this category adds airworthiness standards for aeroplanes with a maximum seating capacity, excluding pilot seats, of 19 or less, a maximum certificated takeoff weight of 19,000 pounds or less, and requires type certification compliance with Annex 8, Part III of the International Civil Aviation Organization, requirements which apply to aeroplanes weighing in excess of 5,700 kilograms (12, 566 pounds), effective August 1, 1987.

Note: *Amendment 23-34 changes the title to read, "Airworthiness Standards, Normal, Utility, Acrobatic and Commuter Category Aeroplanes". Page headings reflecting the new title of the chapter will be changed as pages are reprinted*

This change also includes the following Canadian variations:

Section 523.1301-1 Aeroplane Operation After Ground Cold Soak, object of NPA 84-13 dated 14 September 1984. (Commuter Category Aeroplanes only)

The renumbering of paragraph 523.1581(e) and (f) as 523.1581(f) and (g) because of the incorporation of FAR Amendment 23-34.

The publication of the following new or revised advisory material:

AMA 500C/4A Portable Fire Extinguishers for Use in Aircraft dated 25 March 1987.

AMA 500C/5A Aircraft Operations After Ground Cold Soak dated 25 March 1987.

AMA 523.1581A Aeroplane Flight Manual dated 23 October 1987.

Note: *Changes will be identified by brackets* [ ]; *editorial modifications and typographical corrections will not be identified.*

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Change 523-2 **Effective: January 1, 1989**

This change incorporates the following amendments to the *United States Code of Federal Regulations*, Title 14, Chapter I, Part 23:

Amendment 23-35 "*Cockpit Voice Recorders and Flight Data Recorders*", which amends flight data recorder and cockpit voice recorder regulations to provide more information to accident investigators. Generally, the requirements and parameters for flight recorders are upgraded to the level of the most sophisticated systems available; the use of digital recording equipment will henceforth become the norm. Additionally, uninterrupted sound recording will be required in cockpit voice recorders.

Amendment 23-36 "*Small Aeroplane Airworthiness Review Program*", which upgrades the standards for cabin safety and occupant protection during emergency landing conditions. This action is based on the results of research testing, service experience, and a number of issues discussed at the Small Aeroplane Airworthiness Review Conference, held October 22-26, 1984. This amendment is intended to increase small aeroplane occupant protection during emergency landing conditions.

This change also includes:

References to maximum certified takeoff weight in Section 523.3 changed to 5700 kg.(12,566 lbs) for consistency with international standards published by ICAO; and

The rewriting of the original introduction and forward in the form of a Preamble.

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Change 523-3 **Effective: January 2, 1992**

This change incorporates the following amendments to the *United States Code of Federal Regulations*, Title 14, Chapter 1, Part 23:

Amendment 23-37 "*Revision of General Operating and Flight Rules*" affects U.S. operations only and is not applicable in Canada.

Amendment 23-38 "*Airworthiness Standards; Fatigue Requirements*" which adopts fatigue requirements for empennage, canard, tandem wing and winglet/tip structures. Service history has shown the need to consider empennage fatigue strength during type certification. Also, due to recent design developments where conventional wing and empennage configurations are being replaced or modified by canard, tandem wing and winglet/tip fin structures, fatigue requirements for these new structures are also included.

Amendment 23-39 "*Airworthiness Standards; Commuter Category Aeroplanes*" is based on the requirements adopted by FAR amendment 23-34 and specifies takeoff height and performance airspeeds requirements.

Amendment 23-40 "*Fuel Venting and Exhaust Emission Requirements for Turbine Powered Aeroplanes*" which requires compliance with the new Part 34. Part 34 consolidates all of the applicable aircraft engine fuel venting and exhaust emission requirements of SFAR 27-5, and the test procedures specified under the U.S. regulations implementing the Clear Air Act of the United States of America. In lieu of Part 34, Transport Canada has adopted the standards of Annex 16 to the Convention on International Civil Aviation, Volume II entitled "Aircraft Engine Emission," First Edition - 1981, published by ICAO. Accordingly sections 523.903 and 523.951 are amended to refer to chapter 516, Second Edition, Subchapter B.

Amendment 23-41 amends the airworthiness standards for equipment, systems and installations, and establishes airworthiness standards for the installation of electronic display instrument systems in normal, utility, acrobatic and commuter category aeroplanes. This amendment resulted from the FAA's Small Aeroplane Airworthiness Review Program Amendment No. 5.

Amendment 23-42 provides airworthiness standards for advancements in technology being incorporated in current designs, permits type certification of spin resistant aeroplanes, and reduces the regulatory burden in showing compliance with some of the requirements for the design and type certification of small aeroplanes. New definitions required as a result of these new and amended airworthiness standards are also included. This amendment resulted from the FAA's Small Airworthiness Review Program Amendment No. 2.

This change also includes:

The rewriting of Section 523.1 to refer to the Air Regulation enabling the type approval of aeronautical products;

The revision of the previous Preambles for clarification and completeness; and

A note in section 523.391 referring to the deletion of Appendix B.

The publication of the following new or revised advisory material:

AMA 500C/5B Aircraft Operation After Ground Cold Soak, dated March 2, 1990.

AMA 500C/6 Lightning Protection of Aircraft Fuel Systems, dated Oct. 27, 1989.

AMA 500C/8 Composite Aircraft Structures, dated January 8, 1991.

AMA 523/1 Stalls, Compliance (Commuter Category Aeroplanes), dated January 30, 1990.

AMA 523/3 Turbine Engine Propeller Reversing Systems (Commuter Category Aeroplanes), dated July 12, 1990.

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This change incorporates the following amendments to the *United States Code of Federal Regulations*, Title 14, Chapter 1, Part 23:

Amendment 23-43 "*Small Aeroplane Airworthiness Review Program, Amendment No. 3*" which amends the powerplant and equipment airworthiness standards for normal, utility, acrobatic and commuter category aeroplanes. This amendment is based on certain proposals and recommendations discussed at the Small Aeroplane Airworthiness Review Conference held on October 22-26, 1984 in St. Louis, Missouri, and arises from the recognition by both government and industry, that upgraded standards are needed to maintain an acceptable level of safety for small aeroplanes. The adoption of this FAA amendment was object of Canadian NPA 93-06.

Amendment 23-44 "*Airworthiness Standards, Small Aeroplanes with Stall Speed Greater than 61 knots*", which amends the stalling speed requirements applicable to single-engine aeroplanes and to certain multi-engine small aeroplanes of less than 6,000 pounds maximum weight. The rule permits those aeroplanes to have a stall speed greater than 61 knots, provided they meet certain additional occupant protection standards. These amendments are needed to permit the design and type certification of higher performance aeroplanes with increased cruise speeds and better specific fuel consumption. The amendments are intended to achieve the benefits of certificating higher performance aeroplanes while affording their occupants the same level of protection in an emergency landing that is presently provided by aeroplanes with a 61-knot stall speed. The adoption of this FAA amendment was object of Canadian NPA 93-09.

Amendment 23-45 "*Small Aeroplanes Airworthiness Review Programs, Amendment No. 4*", which changes airframe and flight airworthiness standards for normal, utility, acrobatic and commuter category aeroplanes. The amendments are based on a number of recommendations discussed at the Small Aeroplane Airworthiness Review Conference held on October 22-26, 1984, in St. Louis, Missouri. These updated safety standards will continue to provide an acceptable level of safety in the design requirements for small aeroplanes used in both private and commercial operations. Some of the amendments provide design requirements applicable to advancements in technology being incorporated in current designs. This amendment will also reduce the regulatory burden in showing compliance with some requirements while maintaining an acceptable level of safety. The adoption of this FAA amendment with the exception of section 23.573, was object of Canadian NPA 93-11.

This amendment also includes:

Canadian Variation to section 523.573, paragraph (a)(5) was object of Canadian NPA 94-11 dated 20 August 1994.

FAR section 23.573 "*Damage Tolerance and Fatigue Evaluation of Structure*" which is introduced as part of Amendment 23-45, and concerns aeroplane designs that make extensive use of composite materials, including bonded joints. This section contains the provisions of the earlier FAA Special Conditions, entitled "Evaluation of

Composite Structure" in which a paragraph was devoted to the strength of bonded joints and was intended to ensure that disbonding did not result in a level of strength less than that necessary to carry limit loads.

The Enabling Authority has been replaced by the reference to the Canadian Air Regulations in subsection 523.1(a)

The renumbering of paragraph 523.1581(f) and (g) as 523.1581(g) and (h) because of the incorporation of FAR Amendment 23-45.

The publication of the following advisory material:

AMA 500C/8A Composite Aircraft Structure, dated 1 September 1996.

AMA 500/9 Standards For The Design And Installation of Aircraft Skis, dated 1 September 1996.

AMA 523/2 Flight In Icing Conditions - Performance, dated 1 September 1996.

AMA 523/4 Flight In Icing Conditions - Flight Characteristics, dated 1 September 1996.

AMA 523/5 Performance Credit For Use of Power And Propeller Blade Pitch During Accelerate Stop and Landing Ground Roll, dated 1 September 1996.

The cancellation of AMA 500C/1, Aircraft Equipment Incorporating Digital Computer Technology, 1 May 1986, which is replaced by FAA AC 20-115B.

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Second Edition

Change 523-5 **Published March 1, 2002**

1. General

This change introduces a new format such that Canadian standards in this chapter are now presented in a full-page format. Canadian variations from the FARs are underlined with the FAR text following in bold and italicized characters. The change number and date of affected pages has been removed from the bottom of the page. Instead, affected sections will be followed by change numbers as well as previous change numbers with applicable dates.

With the incorporation of this change, the entire chapter, including all the associated advisory material (AMAs), is republished in a Second Edition.

2. FAR Amendments

This change incorporates the technical standards contained in the following amendments to the United States Code of Federal Regulations, Title 14, Chapter 1, Part 23, for which Notices of Proposed Amendments (NPAs) were issued to solicit industry comments.

These NPAs were issued under the simplified procedure for the amendment of the design standards of the *Airworthiness Manual* and under the usual CARAC consultation process as detailed in the *CARAC Management Charter and Procedures.* All NPAs are noted in the following FAR amendment description.

FAR Amendment 23-46 **Effective: 30 June 1997**

This Amendment entitled "*Airworthiness Standards; Emergency Exit Provisions For Normal, Utility, Aerobatic, and Commuter Category Aeroplanes*", adds requirements for ditching and flight crew emergency exits for these aeroplane categories, and provides alternative emergency exit requirements for commuter category aeroplanes that are consistent with the requirements for similarly sized small transport aeroplanes. (NPA 97-168)

FAR Amendment 23-47

Information Note:

Amendment 23-47, "Revision of Authority Citations" adopts new authority citation for Title 14 of the United States Code of Federal Regulations. It does not apply in Canada.

FAR Amendment 23-48 **Effective: 30 June 1997**

This Amendment entitled "*Airworthiness Standards; Airframe rules Based on European Joint Aviation Requirements*", amends the airframe airworthiness standards as part of the effort to harmonize the FAR and JAR on aeroplane certification in the normal, utility, aerobatic, and commuter categories. (NPA 97-168).

With the adoption of this FAR Amendment, the Canadian variation 523.573(a)(5) is cancelled (see also CARAC Working Group 523-525 recommendations).

FAR Amendment 23-49 **Effective: 30 June 1997**

This Amendment entitled "*Airworthiness Standards; Systems and Equipment Rules Based on European Joint Aviation Requirements*", amends the systems and equipment airworthiness standards as part of the effort to harmonize the FAR and JAR on aeroplane certification in the normal, utility, aerobatic, and commuter categories. (NPA 97-168)

FAR Amendment 23-50 **Effective: 30 June 1997**

This Amendment entitled "*Airworthiness Standards; Flight Rules Based on European Joint Aviation Requirements*", amends the flight airworthiness standards as part of the effort to harmonize the FAR and JAR on aeroplane certification in the normal, utility, aerobatic, and commuter categories. (Amendment 1-43, issued concurrent with Amendment 23-50, adds a new definition of "Maximum speed for stability characteristics, V_{FC}/M_{FC}". This amendment will be adopted in the proposed *Airworthiness Manual* Chapter 500). (NPA 97-168)

FAR Amendment 23-51 **Effective: 30 June 1997**

This Amendment entitled *"Airworthiness Standards; Powerplant Rules Based on European Joint Aviation Requirements*", amends the powerplant airworthiness standards as part of the effort to harmonize the FAR and JAR on aeroplane certification in the normal, utility, aerobatic, and commuter categories. (NPA 97-168)

FAR Amendment 23-52 **Effective: 30 June 1997**

This Amendment entitled "*Powerplant Instruments; Fuel Pressure Indication*", amends the certification requirement for fuel pressure indicators on pump-fed engines of normal, utility, aerobatic, and commuter category aeroplanes to permit regulatory alternatives to fuel pressure indicators to warn pilots of fuel system problems. (NPA 97-168)

FAR Amendment 23-53 **Effective: 29 October 1998**

This Amendment entitled *"Airworthiness Standards: Rain and Hail Ingestion Standards",* establishes revisions to the Federal Aviation Administration's certification standards for rain and hail ingestion for aircraft turbine engines. This amendment addresses engine power-loss and instability phenomena attributed to operation in extreme rain or hail that are not adequately addressed by current requirements. This amendment also generally harmonizes these standards with rain and hail ingestion standards being amended by the Joint Aviation Authorities (JAA).

This amendment establishes nearly uniform standards for engines certified in the United States under 14 CFR part 33 and in the JAA countries under Joint Airworthiness Requirements-Engines (JAR-E), thereby simplifying the certification of engine designs by the FAA and the JAA. (NPA 98-159)

FAR Amendment 23-54 **Effective: 5 March 2001**

This Amendment revises the bird ingestion type certification standards for aircraft turbine engines to better address the actual bird threat encountered in service. This amendment also establishes nearly uniform bird ingestion standards for aircraft turbine engines certified by the United States under FAA standards and by the Joint Aviation Authorities (JAA) countries under JAA standards, thereby simplifying airworthiness approval for import and export. The adoption of this final rule harmonizes Canadian standards with FARs and JARs. (NPA 2000-263)

3. CARAC Working Group

This change also implements the recommendations of CARAC Working Group 523-525.

In 1996 the integration of the existing Design Standards of this Manual into the new *Canadian Aviation Regulations* (CARs), Part V was delayed as a result of a request by Canadian aviation industry to review these standards, in particular the Canadian variations, and all associated Canadian advisory material (AMAs) for their accuracy and appropriateness.

Due to the time frame for CARs implementation, the CARAC Airworthiness Technical Committee V formed several Working Groups made up of industry and Transport Canada specialists to review those variations, AMAs and any applicable Special Conditions and make recommendations to the Committee for their disposition.

The final report of the 523/525 Working Group was completed in June 1997 and all its recommendations were accepted by the CARAC Technical Committee V. With the publication of this Change to Chapter 523, Transport Canada Civil Aviation, Aircraft Certification Branch, starts the implementation of those recommendations.

Therefore, this change includes:

(a) The cancellation of Canadian variation 523.573 (a)(5), which is superseded by the adoption of FAR Amendment 23-48, effective 30 June 1997. The related AMA 500C/8A was revised to ensure consistency in interpretation and application of the requirements related to bonded joints. (NPA 2000-93)

(b) The cancellation of Canadian variations:

523.1581(g) and (h) effective on the date of publication of this change. (NPAs 2000-94 and 2001-012)

(c) The publication of the following new or revised advisory material:

AMA 523/1A Stalls, Compliance, dated 8 November 1999.

AMA 523/2A Flight In Icing Conditions - Performance, dated 29 October 1999.

AMA 523/3A Turbine Engine Propeller Reversing Systems (Commuter Category Aeroplanes), dated 28 August 2001

AMA 523/4A Flight In Icing Conditions - Flight Characteristics, dated 29 October 1999.

AMA 523/5A Performance Credit For Use Of Power And Propeller Blade Pitch During Accelerate Stop And Landing Ground Roll, dated 30 June 1999.

AMA 523/6 Glider and Banner Towing, dated 27 March 2001.

AMA 523.1581/B Aeroplane Flight Manual, dated 29 October 1999.

AMA 500/8B Composite Aircraft Structure, dated 8 November 1999.

AMA 500/9A Standards For The Design And Installation of Aircraft Skis, dated 29 October 1999.

AMA 500/10 Restricted Category Certification of Small Aeroplanes and Helicopters for Special Purpose Operations, dated 23 August 2001.

AMA 500/11 Airworthiness Standards For The Design Of Aircraft Floats, dated 2 February 1998.

AMA 500/12 Carriage of Bulk Liquids in Aircraft, dated 7 April 2000.

(d) The cancellation of the following advisory material:

AMA 500C/2 Multipurpose Electronic Flight Deck Display System, dated 1 May 1986.

AMA 500C/4A Portable Fire Extinguishers for Use in Aircraft, dated 25 March 1987.

4. Miscellaneous Changes

This change also includes editorial corrections, including the update of cross references to CARs (e.g. 523.1).

Due to the consolidation of all regulatory requirements previously found in the Air Regulations and Air Navigation Orders into the new *Canadian Aviation Regulations*, administrative changes are included in this amendment to update the regulatory references and terminology (e.g. *Type Certificate* instead of *Type Approval*).

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Change 523-6 **Effective: December 1, 2004**

In an effort to harmonize our regulatory guidance documents with those of other international aviation authorities and other branches within Transport Canada Civil Aviation (TCCA), the Aircraft Certification Branch has decided to replace existing Airworthiness Manual Advisories (AMA) related to certification of aeronautical products with new Advisory Circulars (AC). While the content of the new ACs will remain technically the same as the corresponding AMAs, which they will replace, the format of the ACs will be standardized to conform to other guidance documents published within the branch.

This change in guidance documentation becomes effective 1 December 2004 at which time the AMAs will be cancelled and replaced by their corresponding Advisory Circular concurrent with the next publishing of the *Canadian Aviation Regulations* (CAR). After this time, the CARAC Secretariat will no longer publish these AMAs and, consequently, ACs will not be published with their corresponding AWM Chapter. As of the 1 December 2004 issue of the CARs, any affected AMA references and content will have been removed. However, the AMA Index found in AMA 500/00 will, for now, continue to exist to provide a cross-reference between the old AMAs and the new ACs.

Change 523-7 **Published: December 30, 2006**

This change incorporates the following amendments to the United States Code of Federal Regulations, Title 14, Chapter I, Part 23:

Correction to FAR Amendment 23-54 **Effective: June 8, 2004**

Table of Change Information	
Notice of Proposed Amendment	**Amended Sections**
▪ 2004-030	▪ 523.903

Proposed adoption by reference of FAA correction to FAR Amendment No. 23-54. FAR Amendment No. 23-54 had originally been adopted with NPA 2000-263 and published at Change 523-5 of Airworthiness Manual Chapter 523. As published, the standards contain errors that may prove to be misleading and need to be clarified. Specifically, subparagraph (a)(2)(i) of section 523.903 is changed to read as follows:

"(i) Sections 533.76, 533.77 and 533.78 of this manual in effect on 5 March, 2001, or as subsequently amended; or..."

Correction to FAR Amendment 23-50 **Effective: June 3, 2005**

Table of Change Information	
Notice of Proposed Amendment	**Amended Sections**
▪ 2005-012	▪ 523.49 ▪ 523.201

Proposed adoption by reference of forthcoming FAA correction to 14 CFR Part 23, Sections 23.49 and 23.201, paragraph (c) and incorporation in Chapter 523 of the *Airworthiness Manual*.

The printed version of the US Code of Federal Regulations, 14 CFR Part 23, Section 23.49 and the printed and electronic version of Section 23.201 contain editorial errors.

The title of Section 23.49 reads:

"Stalling period" instead of "Stalling speed", and the text of Section 23.201 paragraph (c) refers to "minimum steady slight speed" instead of "minimum steady flight speed". The FAA informed Transport Canada that the two editorial errors would be corrected during the next revision of the regulations without going through the NPRM process.

Change 523-8 **Published: December 30, 2008**

This change incorporates the following amendment to the United States Code of Federal Regulations, Title 14, Chapter I, Part 23:

***Information Note**: Amendment 23-55, which was for a revision to the U.S. authority citation, is not applicable in Canada and is not adopted. There is presently no Amendment 23-56 as this number was skipped in the U.S. 14 CFR part 23.*

FAR Amendment 23-57 **Effective: October 30, 2008**

Table of Change Information	
Notice of Proposed Amendment	**Amended Sections**
▪ 2008-001	▪ 523.1308 ▪ Appendix J

This amendment entitled "High-Intensity Radiated Fields (HIRF) Protection for Aircraft Electrical and Electronic Systems" revises the airworthiness standards for Normal, Utility, Aerobatic and Commuter Category Aeroplanes. This action is necessary due to the vulnerability of aircraft electrical and electronic systems and the increasing use of high-power radio frequency transmitters. It is intended to create a safer operating environment for civil aviation by protecting aircraft and their electrical and electronic systems from the adverse effects of HIRF.

Change 523-9 **Published: June 30, 2009**

This change incorporates the following amendment to the United States Code of Federal Regulations, Title 14, Chapter I, Part 23:

FAR Amendment 23-58 **Effective: May 11, 2009**

Table of Change Information	
Notice of Proposed Amendment	**Amended Sections**
▪ 2008-065	▪ 523.1457 ▪ 523.1459

This amendment amends cockpit voice recorder (CVR) and digital flight data recorder (DFDR) design standards. This amendment increases the duration of certain CVR recordings, requires physical separation of the DFDR and CVR, improves the reliability of the power supplies to both the CVR and DFDR, and requires that certain datalink communications received on an aircraft be recorded if datalink communication equipment is installed. This amendment is based on recommendations issued by the National Transportation Safety Board following its investigations of several accidents and incidents. These changes to CVR and DFDR systems are intended to improve the quality and quantity of information recorded and increase the potential for retaining important information needed for accident and incident investigations.

Change 523-10 **Published: December 1, 2009**

On December 1, 2009, Part V Subpart 21 of the *Canadian Aviation Regulations* (CAR 521) came into force. CAR 521 replaces the following Regulations in Part V—Airworthiness:

Subpart 11 - Approval of the Type Design of an Aeronautical Product

Subpart 13 - Approval of Modification and Repair Designs

Subpart 16 - Aircraft Emissions

Subpart 22 - Gliders and Powered Gliders

Subpart 23 - Normal, Utility, Aerobatic and Commuter Category Aeroplanes

Subpart 25 - Transport Category Aeroplanes

Subpart 27 - Normal Category Rotorcraft

Subpart 29 - Transport Category Rotorcraft

Subpart 31 - Manned Free Balloons

Subpart 33 - Aircraft Engines

Subpart 35 - Aircraft Propellers

Subpart 37 - Aircraft Appliances and Other Aeronautical Products

Subpart 41 - Airships

Subpart 51 - Aircraft Equipment

Subpart 91 - Service Difficulty Reporting

Subpart 93 - Airworthiness Directives

In addition, with publication of CAR 521, the following Chapters of the Airworthiness Manual have been withdrawn:

Chapter 511 - Approval of the Type Design of an Aeronautical Product

Chapter 513 - Approval of Modification and Repair Designs

Standard 591 - Service Difficulty Reporting

Standard 593 - Airworthiness Directives

This change amends section 523.1 to reflect changes in legal drafting style, in terminology and in references required because of the introduction of CAR 521. In addition, subsection 521.31(1) of the CARs is now used to legally enable this Chapter of the AWM.

Change 523-11 **Published: June 1, 2010**

This Change incorporates the following amendments to the United States Code of Federal Regulations, Title 14, Chapter I, Part 23:

FAR Amendment 23-48, correction **Effective: January 29, 2010**

Table of Change Information	
Notice of Proposed Amendment	**Amended Sections**
▪ 2009-007	▪ 523.573

This amendment corrects a paragraph reference in 523.573(b), which was introduced into Chapter 523 with NPA 97-168 (adopting FAR Amdt. 23-48), effective 30 June 1997 and as published in Change 523-5. In FAR Amdt. 23-48, a paragraph reference was inadvertently changed. This amendment incorporates the FAA technical amendment published in the Federal Register [73 FR 19746, Apr. 11, 2008], correcting the error to ensure the requirement is clear and accurate.

FAR Amendment 23-59 **Effective: January 29, 2010**

Table of Change Information	
Notice of Proposed Amendment	**Amended Sections**
▪ 2009-015	▪ 523.905 ▪ 523.907

This amendment entitled "Airworthiness Standards; Propellers" addressed advances in propeller technology of the past twenty years and not previously adequately addressed in the standards. The new standards address these advances in technology and harmonize Transport Canada Civil Aviation (TCCA), Federal Aviation Administration (FAA) and European Aviation Safety Agency (EASA) propeller certification requirements, thereby simplifying airworthiness approvals for imports and exports. This amendment modifies 523.905(d) and 523.907(a) and (b) and add paragraph 523.907(c).

PART V - AIRWORTHINESS

(2002/03/01)

AIRWORTHINESS MANUAL CHAPTER 523 NORMAL, UTILITY, AEROBATIC AND COMMUTER CATEGORY AEROPLANES

SUBCHAPTER A

General

523.1 *Applicability*

(a) This chapter sets out airworthiness standards for the issue of type certificates and changes to those type certificates, for aeroplanes in the normal, utility, aerobatic and commuter categories.

(b) Reserved.
(amended 2009/12/01)

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))
(Change 523-4 (96-09-01))
(Change 523-5)

523.2 *Special Retroactive Requirements*

(a) Subject to the requirements of CAR 605.24 and irrespective of the type certification basis, each normal, utility, and aerobatic category aeroplane having a passenger seating configuration, excluding pilot seats, of nine or less, manufactured after December 12, 1986, or any such foreign aeroplane for entry into Canada must provide a safety belt and shoulder harness for each forward or aft-facing seat which will protect the occupant from serious head injury when subjected to the inertia loads resulting from the ultimate static load factors prescribed in 523.561 (b) (2) of this chapter, or which will provide the occupant protection specified in 523.562 of this chapter when that section is applicable to the aeroplane. For other seat orientation, the seat/restraint system must be designed to provide a level of occupant protection equivalent to that provided for forward of aft-facing seats with a safety belt and shoulder harness installed.

(b) Each shoulder harness installed at a flight crew member station, as required by this section, must allow the crew member, when seated with the safety belt and shoulder harness fastened, to perform all functions necessary for flight operations.

(c) For the purpose of this section, the date of manufacture is:

(1) The date the statement of conformity or equivalent inspection acceptance records, reflects that the aeroplane is complete and meets the type design data approved by the Minister; or

(2) In the case of a foreign manufactured aeroplane, the date the foreign civil airworthiness authority certifies the aeroplane is complete and issues an original standard airworthiness certificate, or the equivalent in that country.

(Change 523-1 (88-01-01))
(Change 523-2 (89-01-01))
(Change 523-3 (92-01-02))
(Change 523-5)

523.3 *Aeroplane Categories*

(a) The normal category is limited to aeroplanes that have a seating configuration, excluding pilot seats, of nine or less, a maximum certificated takeoff weight of 5700 kg (12,566 lbs.) or less, and intended for non-aerobatic operation. Non-aerobatic operation includes:

FAR:

(a) The normal category is limited to airplanes that have a seating configuration, excluding pilot seats of nine or less, a maximum certificated takeoff weight of 12,500 lbs (5670 kg) or less, and intended for non-acrobatic operation. Non-acrobatic operation includes:

(1) Any manoeuvre incident to normal flying;

(2) Stalls (except whip stalls); and

(3) Lazy eights, chandelles, and steep turns, in which the angle of bank is not more than 60°.

(b) The utility category is limited to aeroplanes that have a seating configuration, excluding pilot seats, of nine or less, a maximum certificated takeoff weight of 5700 kg (12,566 lbs.) or less, and intended for limited aerobatic operation. Aeroplanes certificated in the utility category may be used in any of the operations covered under paragraph (a) of this section and in limited aerobatic operations. Limited aerobatic operation includes:

FAR:

(b) The utility category is limited to airplanes that have a seating configuration, excluding pilot seats, of nine or less, a maximum certificated takeoff weight of 12,500 lbs (5670 kg) or less, and intended for limited acrobatic operation. Airplanes certificated in the utility category may be used in any of the operations covered under paragraph (a) of this section and in limited acrobatic operations. Limited acrobatic operation includes

(1) Spins (if approved for the particular type of aeroplane); and

(2) Lazy eights, chandelles, and steep turns, or similar manoeuvres, in which the angle of bank is more than 60 degrees but not more than 90 degrees.

(c) The aerobatic category is limited to aeroplanes that have a seating configuration, excluding pilot seats, of nine or less, a maximum certificated takeoff weight of 5700 kg (12,566 lbs.) or less, and intended for use without restrictions, other than those shown to be necessary as a result of required flight tests.

FAR:

(c) The acrobatic category is limited to airplanes that have a seating configuration, excluding pilot seats, of nine or less, a maximum certificated takeoff weight of 12,500 lbs (5670 kg) or less, and intended for use without restrictions, other than those shown to be necessary as a result of required flight tests.

(d) [The commuter category is limited to propeller-driven, multi-engine aeroplanes that have a seating configuration, excluding pilot seats, of 19 or less, and a maximum certificated takeoff weight of 8618 kg (19,000 lbs.) or less. The commuter category operation is limited to any manoeuvre incident to normal flying, stalls (except whip stalls), and steep turns, in which the angle of bank is not more than 60 degrees.

(e) [Except for commuter category, aeroplanes may be type certificated in more than one category if the requirements of each requested category are met.]

(Change 523-1 (88-01-01))
(Change 523-5)

SUBCHAPTER B

Flight - General

523.21 *Proof of Compliance*

(a) Each requirement of this subchapter must be met at each appropriate combination of weight and centre of gravity within the range of loading conditions for which certification is requested. This must be shown:

(1) By tests upon an aeroplane of the type for which certification is requested, or by calculations based on, and equal in accuracy to, the results of testing; and

(2) By systematic investigation of each probable combination of weight and centre of gravity, if compliance cannot be reasonably inferred from combinations investigated.

(b) The following general tolerances are allowed during flight testing. However, greater tolerances may be allowed in particular tests (see Table below).

Item	*Tolerance*
Weight. Critical items affected by weight. C.G.	+ 5%, -10%. + 5%, -1%. + 7% total travel.

523.23 *Load Distribution Limits*

(a) Ranges of weights and centres of gravity within which the aeroplane may be safely operated must be established. If a weight and centre of gravity combination is allowable only within certain lateral load distribution limits that could be inadvertently exceeded, these limits must be established for the corresponding weight and centre of gravity combinations.

(b) The load distribution limits may not exceed any of the following:

(1) The selected limits;

(2) The limits at which the structure is proven; or

(3) The limits at which compliance with each applicable flight requirement of this subchapter is shown.

(Change 523-4 (96-09-01))

523.25 *Weight Limits*

(a) [*Maximum weight*. The maximum weight is the highest weight at which compliance with each applicable requirement of this chapter (other than those complied with at the design landing weight) is shown. The maximum weight must be established so that it is:

(1) [Not more than the least of:

(i) [The highest weight selected by the applicant; or]

(ii) The design maximum weight, which is the highest weight at which compliance with each applicable structural loading condition of this Chapter (other than those complied with at the design landing weight) is shown; or

(iii) [The highest weight at which compliance with each applicable flight requirement is shown, and]

(2) Not less than the weight with:

(i) Each seat occupied, assuming a weight of 170 pounds for each occupant for normal and commuter category aeroplanes, and 190 pounds for utility and aerobatic category aeroplanes, except that seats other than pilot seats may be placarded for a lesser weight; and

(A) Oil at full capacity, and

(B) At least enough fuel for maximum continuous power operation of at least 30 minutes for day-VFR approved aeroplanes and at least 45 minutes for night-VFR and IFR approved aeroplanes; or

(ii) The required minimum crew, and fuel and oil to full tank capacity.

(b) *Minimum weight.* The minimum weight (the lowest weight at which compliance with each applicable requirement of this Chapter is shown) must be established so that it is not more than the sum of:

(1) The empty weight determined under 523.29;

(2) The weight of the required minimum crew (assuming a weight of 170 pounds for each crew member); and

(3) The weight of:

(i) For turbojet powered aeroplanes, 5 percent of the total fuel capacity of that particular fuel tank arrangement under investigation; and

(ii) For other aeroplanes, the fuel necessary for one-half hour of operation at maximum continuous power.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

523.29 *Empty Weight and Corresponding Centre of Gravity*

(a) The empty weight and corresponding centre of gravity must be determined by weighing the aeroplane with:

(1) Fixed ballast;

(2) Unusable fuel determined under 523.959; and

(3) Full operating fluids, including:

(i) Oil;

(ii) Hydraulic fluid; and

(iii) Other fluids required for normal operation of aeroplane systems, except potable water, lavatory precharge water, and water intended for injection in the engines.

(b) The condition of the aeroplane at the time of determining empty weight must be one that is well defined and can be easily repeated.

523.31 *Removable Ballast*

Removable ballast may be used in showing compliance with the flight requirement of this subchapter, if:

(a) The place for carrying ballast is properly designed and installed, and is marked under 523.1557; and

(b) Instructions are included in the Aeroplane Flight Manual, approved manual material, or markings and placards, for the proper placement of the removable ballast under each loading condition for which removable ballast is necessary.

523.33 *Propeller Speed and Pitch Limits*

(a) *General.* The propeller speed and pitch must be limited to values that will assure safe operation under normal operating conditions.

(b) *Propellers not controllable in flight.* For each propeller whose pitch cannot be controlled in flight:

(1) [During takeoff and initial climb at the all engine(s) operating climb speed specified in 523.65, the propeller must limit the engine r.p.m., at full throttle or at maximum allowable takeoff manifold pressure, to a speed not greater than the maximum allowable takeoff r.p.m.; and

(2) [During a closed throttle glide, at V_{NE}, the propeller may not cause an engine speed above 110 percent of maximum continuous speed.]

(c) *Controllable pitch propellers without constant speed controls.* Each propeller that can be controlled in flight, but that does not have constant speed controls, must have a means to limit the pitch range so that:

(1) The lowest possible pitch allows compliance with paragraph (b) (1) of this section; and

(2) The highest possible pitch allows compliance with paragraph (b) (2) of this section.

(d) *Controllable pitch propellers with constant speed controls.* Each controllable pitch propeller with constant speed controls must have:

(1) With the governor in operation, a means at the governor to limit the maximum engine speed to the maximum allowable takeoff r.p.m.; and

(2) With the governor inoperative, the propeller blades at the lowest possible pitch, with takeoff power, the aeroplane stationary, and no wind, either:

(i) A means to limit the maximum engine speed to 103 percent of the maximum allowable takeoff r.p.m., or

(ii) For an engine with an approved overspeed, a means to limit the maximum engine and propeller speed to not more than the maximum approved overspeed.

(Change 523-4 (96-09-01))
(Change 523-5)

Performance

523.45 *General*

(a) [Unless otherwise prescribed, the performance requirements of this chapter must be met for:

(1) [Still air and standard atmosphere; and

(2) [Ambient atmospheric conditions, for commuter category aeroplanes, for reciprocating engine-powered aeroplanes of more than 6,000 pounds maximum weight, and for turbine engine-powered aeroplanes.

(b) [Performance data must be determined over not less than the following ranges of conditions:

[(1) Airport altitudes from sea level to 10,000 feet; and

[(2) For reciprocating engine-powered aeroplanes of 6,000 pounds, or less, maximum weight, temperature from standard to 30°C above standard; or

[(3) For reciprocating engine-powered aeroplanes of more than 6,000 pounds maximum weight and turbine engine-powered aeroplanes, temperature from standard to 30°C above standard, or the maximum ambient atmospheric temperature at which compliance with the cooling provisions of 523.1041 to 523.1047 is shown, if lower.

(c) [Performance data must be determined with the cowl flaps or other means for controlling the engine cooling air supply in the position used in the cooling tests required by 523.1041 to 523.1047.

(d) [The available propulsive thrust must correspond to engine power, not exceeding the approved power, less:

(1) [Installation losses; and

(2) [The power absorbed by the accessories and services appropriate to the particular ambient atmospheric conditions and the particular flight condition.

(e) [The performance, as affected by engine power or thrust, must be based on a relative humidity:

(1) [Of 80 percent at and below standard temperature; and

(2) [From 80 percent, at the standard temperature, varying linearly down to 34 percent at the standard temperature plus 50°F.

[(f) Unless otherwise prescribed, in determining the takeoff and landing distances, changes in the aeroplane's configuration, speed, and power must be made in accordance with procedures established by the applicant for operation in service. These procedures

must be able to be executed consistently by pilots of average skill in atmospheric conditions reasonably expected to be encountered in service.

(g) The following, as applicable, must be determined on a smooth, dry, hard-surfaced runway:

(1) Takeoff distance of 523.53(b);

(2) Accelerate-stop distance of 523.55;

(3) Takeoff distance and takeoff run of 523.59; and

(4) Landing distance of 523.75.

Information Note: *The effect on these distances of operation on other types of surfaces (for example, grass, gravel) when dry, may be determined or derived and these surfaces listed in the Aeroplane Flight Manual in accordance with 523.1583(p).*

(h) For commuter category aeroplanes, the following also apply:

(1) Unless otherwise prescribed, the applicant must select the takeoff, en route, approach, and landing configurations for the aeroplane.

(2) The aeroplane configuration may vary with weight, altitude, and temperature, to the extent that they are compatible with the operating procedures required by paragraph (h)(3) of this section.

(3) Unless otherwise prescribed, in determining the critical-engine-inoperative take-off performance, takeoff flight path, and accelerate-stop distance, changes in the aeroplane's configuration, speed, and power must be made in accordance with procedures established by the applicant for operation in service.

(4) Procedures for the execution of discontinued approaches and balked landings associated with the conditions prescribed in 523.67(c)(4) and 523.77(c) must be established.

(5) The procedures established under paragraphs (h)(3) and (h)(4) of this section must:

(i) Be able to be consistently executed by a crew of average skill in atmospheric conditions reasonably expected to be encountered in service;

(ii) Use methods or devices that are safe and reliable; and

(iii) Include allowance for any reasonably expected time delays in the execution of the procedures.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

523.49 *Stalling Speed*
(amended 2005/06/03)

(a) V_{SO} and V_{S1} are the stalling speeds, or the minimum steady speed flight speeds, in knots (CAS), at which the aeroplane is controllable, with:

(1) For reciprocating engine-powered aeroplanes, the engine(s) idling, the throttle(s) closed or at not more than the power necessary for zero thrust at a speed not more than 110 percent of the stalling speed;

(2) For turbine engine-powered aeroplanes, the propulsive thrust not greater than zero at the stalling speed, or, if the resultant thrust has no appreciable effect on the stalling speed, with engine(s) idling and throttle(s) closed;

(3) The propeller(s) in the takeoff position;

(4) The aeroplane in the condition existing in the test, in which V_{SO} and V_{S1} are being used;

(5) The centre of gravity in the position that results in the highest value of V_{SO} and V_{S1}; and

(6) The weight used when V_{SO} and V_{S1} are being used as a factor to determine compliance with a required performance standard.

(b) V_{SO} and V_{S1} must be determined by flight tests, using the procedure and meeting the flight characteristics specified in 523.201.

(c) Except as provided in paragraph (d) of this section, V_{SO} and V_{S1} at maximum weight must not exceed 61 knots for:

(1) Single-engine aeroplanes; and

(2) Multi-engine aeroplanes of 6,000 pounds or less maximum weight that cannot meet the minimum rate of climb specified in 523.67(a)(1) with the critical engine inoperative.

(d) All single-engine aeroplanes, and those multi-engine aeroplanes of 6,000 pounds or less maximum weight with a V_{SO} of more than 61 knots that do not meet the requirements of 523.67(a)(1), must comply with 523.562(d).

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

523.51 *Takeoff Speeds*

(a) For normal, utility, and aerobatic category aeroplanes, rotation speed, V_R, is the speed at which the pilot makes a control input, with the intention of lifting the aeroplane out of contact with the runway or water surface.

(1) For multi-engine landplanes, V_R, must not be less than the greater of 1.05 V_{MC}; or 1.10 V_{S1};

(2) For single-engine landplanes, V_R, must not be less than V_{S1}; and

(3) For seaplanes and amphibians taking off from water, V_R, may be any speed that is shown to be safe under all reasonably expected conditions, including turbulence and complete failure of the critical engine.

(b) For normal, utility, and aerobatic category aeroplanes, the speed at 50 feet above the takeoff surface level must not be less than:

[(1) For multi-engine aeroplanes, the highest of:

[(i) A speed that is shown to be safe for continued flight (or emergency landing, if applicable) under all reasonably expected conditions, including turbulence and complete failure of the critical engine;

[(ii) 1.10 V_{MC}; or

[(iii) 1.20 V_{S1};

[(2) For single-engine aeroplanes, the higher of:

[(i) A speed that is shown to be safe under all reasonably expected conditions, including turbulence and complete engine failure; or

[(ii) 1.20 V_{S1}.

(c) [For commuter category aeroplanes, the following apply:

[(1) V_1 must be established in relation to V_{EF} as follows:

[(i) V_{EF} is the calibrated airspeed at which the critical engine is assumed to fail. V_{EF} must be selected by the applicant but must not be less than 1.05 V_{MC} determined under 523.149(b) or, at the option of the applicant, not less than V_{MCG} determined under 523.149(f).

[(ii) The takeoff decision speed, V_1, is the calibrated airspeed on the ground at which, as a result of engine failure or other reasons, the pilot is assumed to have made a decision to continue or discontinue the takeoff. The takeoff decision speed, V_1, must be selected by the applicant but must not be less than V_{EF} plus the speed gained with the critical engine inoperative during the time interval between the instant at which the critical engine is failed and the instant at which the pilot recognizes and reacts to the engine failure, as indicated by the pilot's application of the first retarding means during the accelerate-stop determination of 523.55.

[(2) The rotation speed, V_R, in terms of calibrated airspeed, must be selected by the applicant and must not be less than the greatest of the following:

[(i) V_1;

[(ii) 1.05 V_{MC} determined under 523.149(b);

[(iii) 1.10 V_{S1}; or

[(iv) The speed that allows attaining the initial climb-out speed, V_2, before reaching a height of 35 feet above the takeoff surface in accordance with 523.57(c)(2).

[(3) For any given set of conditions, such as weight, altitude, temperature, and configuration, a single value of V_R must be used to show compliance with both the one-engine-inoperative takeoff and all-engines-operating takeoff requirements.

[(4) The takeoff safety speed, V_2, in terms of calibrated airspeed, must be selected by the applicant so as to allow the gradient of climb required in 523.67(c)(1) and (c)(2) but must not be less than 1.10 V_{MC} or less than 1.20 V_{S1}.

[(5) The one-engine-inoperative takeoff distance, using a normal rotation rate at a speed 5 knots less than V_R, established in accordance with paragraph (c)(2) of this section, must be shown not to exceed the corresponding one-engine-inoperative takeoff distance, determined in accordance with 523.57 and 523.59(a)(1), using the established V_R. The takeoff, otherwise performed in accordance with 523.57, must be continued safely from the point at which the aeroplane is 35 feet above the takeoff surface and at a speed not less than the established V_2 minus 5 knots.

[(6) The applicant must show, with all engines operating, that marked increases in the scheduled takeoff distances, determined in accordance with 523.59(a)(2), do not result from over-rotation of the aeroplane or out-of-trim conditions.]

(Change 523-1 (88-01-01))
(Change 523-5)

523.53 *[Takeoff Performance*

(a) [For normal, utility, and aerobatic category aeroplanes, the takeoff distance must be determined in accordance with paragraph (b) of this section, using speeds determined in accordance with 523.51(a) and (b).

(b) [For normal, utility, and aerobatic category aeroplanes, the distance required to take-off and climb to a height of 50 feet above the takeoff surface must be determined for each weight, altitude, and temperature within the operational limits established for take-off with:

(1) [Takeoff power on each engine;

(2) [Wing flaps in the takeoff position(s); and

[(3) Landing gear extended.

(c) [For commuter category aeroplanes, takeoff performance, as required by 523.55 through 523.59, must be determined with the operating engine(s) within approved operating limitations.]

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

523.55 *Accelerate-Stop Distance*

For each commuter category aeroplane, the accelerate-stop distance must be determined as follows:

(a) [The accelerate-stop distance is the sum of the distances necessary to:

(1) [Accelerate the aeroplane from a standing start to V_{EF} with all engines operating;

(2) [Accelerate the aeroplane from V_{EF} to V_1, assuming the critical engine fails at V_{EF}; and

[(3) Come to a full stop from the point at which V_1 is reached.

(b) [Means other than wheel brakes may be used to determine the accelerate-stop distances if that means:]

(1) Is safe and reliable;

(2) Is used so that consistent results can be expected under normal operating conditions; and

(3) Is such that exceptional skill is not required to control the aeroplane.

(Change 523-1 (88-01-01))
(Change 523-5)

523.57 *Takeoff Path*

For each commuter category aeroplane, the takeoff path is as follows:

(a) [The takeoff path extends from a standing start to a point in the takeoff at which the aeroplane is 1,500 feet above the takeoff surface at or below which height the transition from the takeoff to the enroute configuration must be completed; and]

(1) The takeoff path must be based on the procedures prescribed in 523.45;

(2) The aeroplane must be accelerated on the ground to V_{EF} at which point the critical engine must be made inoperative and remain inoperative for the rest of the takeoff; and

(3) After reaching V_{EF}, the aeroplane must be accelerated to V_2.

(b) [During the acceleration to speed V_2, the nose gear may be raised off the ground at a speed not less than V_R. However, landing gear retraction must not be initiated until the aeroplane is airborne.]

(c) During the takeoff path determination, in accordance with paragraphs (a) and (b) of this section:

(1) [The slope of the airborne part of the takeoff path must not be negative at any point;]

(2) The aeroplane must reach V_2 before it is 35 feet above the takeoff surface, and must continue at a speed as close as practical to, but not less than V_2, until it is 400 feet above the takeoff surface;

(3) [At each point along the takeoff path, starting at the point at which the aeroplane reaches 400 feet above the takeoff surface, the available gradient of climb must not be less than:]

(i) 1.2 percent for two-engine aeroplanes;

(ii) 1.5 percent for three-engine aeroplanes;

(iii) 1.7 percent for four-engine aeroplanes; and

(4) [Except for gear retraction and automatic propeller feathering, the aeroplane configuration must not be changed, and no change in power that requires action by the pilot may be made, until the aeroplane is 400 feet above the takeoff surface.

(d) [The takeoff path to 35 feet above the takeoff surface must be determined by a continuous demonstrated takeoff.

[(e) The takeoff path to 35 feet above the takeoff surface must be determined by synthesis from segments; and

[(1) The segments must be clearly defined and must be related to distinct changes in the configuration, power, and speed;

[(2) The weight of the aeroplane, the configuration, and the power must be assumed constant throughout each segment and must correspond to the most critical condition prevailing in the segment; and

[(3) The takeoff flight path must be based on the aeroplane's performance without utilizing ground effect.]

(Change 523-1 (88-01-01))
(Change 523-5)

523.59 *Takeoff Distance and Takeoff Run*

[For each commuter category aeroplane, the takeoff distance and, at the option of the applicant, the takeoff run, must be determined.]

(a) Takeoff distance is the greater of:

(1) The horizontal distance along the takeoff path from the start of the takeoff to the point at which the aeroplane is 35 feet above the takeoff surface as determined under 523.57; or

(2) [With all engines operating, 115 percent of the horizontal distance from the start of the takeoff to the point at which the aeroplane is 35 feet above the takeoff surface, determined by a procedure consistent with 523.57.

(b) [If the takeoff distance includes a clearway, the takeoff run is the greater of:

(1) [The horizontal distance along the takeoff path from the start of the takeoff to a point equidistant between the lift-off point and the point at which the aeroplane is 35 feet above the takeoff surface as determined under 523.57; or

(2) [With all engines operating, 115 percent of the horizontal distance from the start of the takeoff to a point equidistant between the lift off point and the point at which the aeroplane is 35 feet above the takeoff surface, determined by a procedure consistent with 523.57.]

(Change 523-1 (88-01-01))
(Change 523-5)

523.61 *Takeoff Flight Path*

For each commuter category aeroplane, the takeoff flight path must be determined as follows:

(a) The takeoff flight path begins at 35 feet above the takeoff surface at the end of the takeoff distance determined in accordance with 523.59.

(b) The net takeoff flight path data must be determined so that they represent the actual takeoff flight paths, as determined in accordance with 523.57 and with paragraph (a) of this section, reduced at each point by a gradient of climb equal to:

(1) 0.8 percent for two-engine aeroplanes;

(2) 0.9 percent for three-engine aeroplanes; and

(3) 1.0 percent for four-engine aeroplanes;

(c) The prescribed reduction in climb gradient may be applied as an equivalent reduction in acceleration along that part of the takeoff flight path at which the aeroplane is accelerated in level flight.

(Change 523-1 (88-01-01))

[523.63 *Climb: General*

[(a) Compliance with the requirements of 523.65, 523.66, 523.67, 523.69, and 523.77 must be shown:

[(1) Out of ground effect; and

[(2) At speeds that are not less than those at which compliance with the powerplant cooling requirements of 523.1041 to 523.1047 has been demonstrated; and

[(3) Unless otherwise specified, with one-engine-inoperative, at a bank angle not exceeding 5 degrees.

[(b) For normal, utility, and aerobatic category reciprocating engine-powered aeroplanes of 6,000 pounds or less maximum weight, compliance must be shown with 523.65(a), 523.67(a), where appropriate, and 523.77(a) at maximum takeoff or landing weight, as appropriate, in a standard atmosphere.

[(c) For normal, utility, and aerobatic category reciprocating engine-powered aeroplanes of more than 6,000 pounds maximum weight, and turbine engine-powered aeroplanes in the normal, utility, and aerobatic category, compliance must be shown at weights as a function of airport altitude and ambient temperature, within the operational limits established for takeoff and landing, respectively, with:

[(1) Sections 523.65(b) and 523.67(b) (1) and (2), where appropriate, for takeoff, and

[(2) Section 523.67(b)(2), where appropriate, and 523.77(b), for landing.

[(d) For commuter category aeroplanes, compliance must be shown at weights as a function of airport altitude and ambient temperature within the operational limits established for takeoff and landing, respectively, with:

[(1) Sections 523.67(c)(1), 523.67(c) (2), and 523.67(c)(3) for takeoff; and

[(2) Sections 523.67(c)(3), 523.67(c) (4), and 523.77(c) for landing.]

(Change 523-5)

523.65 *Climb: All Engines Operating*

(a) [Each normal, utility, and aerobatic category reciprocating engine-powered aeroplane of 6,000 pounds or less maximum weight must have a steady climb gradient at sea level of at least 8.3 percent for landplanes or 6.7 percent for seaplanes and amphibians with:

(1) [Not more than maximum continuous power on each engine;

(2) [The landing gear retracted;

(3) [The wing flaps in the takeoff position(s); and

(4) [A climb speed not less than the greater of 1.1 V_{MC} and 1.2 V_{S1} for multi-engine aeroplanes and not less than 1.2 V_{S1} for single-engine aeroplanes.

(b) [Each normal, utility, and aerobatic category reciprocating engine-powered aeroplane of more than 6,000 pounds maximum weight and turbine engine-powered aeroplanes in the normal, utility, and aerobatic category must have a steady gradient of climb after take-off of at least 4 percent with:

(1) [Takeoff power on each engine;

(2) [The landing gear extended, except that if the landing gear can be retracted in not more than seven seconds, the test may be conducted with the gear retracted;

[(3) The wing flaps in the takeoff position(s); and

[(4) A climb speed as specified in 523.65(a)(4).]

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

[523.66 *Takeoff Climb: One-Engine Inoperative*

[For normal, utility, and aerobatic category reciprocating engine-powered aeroplanes of more than 6,000 pounds maximum weight, and turbine engine-powered aeroplanes in the normal, utility, and aerobatic category, the steady gradient of climb or descent must be determined at each weight, altitude, and ambient temperature within the operational limits established by the applicant with:

[(a) The critical engine inoperative and its propeller in the position it rapidly and automatically assumes;

[(b) The remaining engine(s) at takeoff power;

[(c) The landing gear extended, except that if the landing gear can be retracted in not more than seven seconds, the test may be conducted with the gear retracted;

[(d) The wing flaps in the takeoff position(s);

[(e) The wings level; and

[(f) A climb speed equal to that achieved at 50 feet in the demonstration of 523.53.]

(Change 523-5)

523.67 *Climb: One-Engine Inoperative*

(a) [For normal, utility, and aerobatic category reciprocating engine-powered aeroplanes of 6,000 pounds or less maximum weight, the following apply:

(1) [Except for those aeroplanes that meet the requirements prescribed in 523.562(d), each aeroplane with a V_{SO} of more than 61 knots must be able to maintain a steady climb gradient of at least 1.5 percent at a pressure altitude of 5,000 feet with the:

[(i) Critical engine inoperative and its propeller in the minimum drag position;

[(ii) Remaining engine(s) at not more than maximum continuous power;

[(iii) Landing gear retracted;

[(iv) Wing flaps retracted; and

[(v) Climb speed not less than 1.2 V_{S1}.

(2) [For each aeroplane that meets the requirements prescribed in 523.562(d), or that has a V_{S0} of 61 knots or less, the steady gradient of climb or descent at a pressure altitude of 5,000 feet must be determined with the:

[(i) Critical engine inoperative and its propeller in the minimum drag position;

[(ii) Remaining engine(s) at not more than maximum continuous power;

[(iii) Landing gear retracted;

[(iv) Wing flaps retracted; and

[(v) Climb speed not less than 1.2 V_{S1}.

(b) [For normal, utility, and aerobatic category reciprocating engine-powered aeroplanes of more than 6,000 pounds maximum weight, and turbine engine-powered aeroplanes in the normal, utility, and aerobatic category:

(1) [The steady gradient of climb at an altitude of 400 feet above the takeoff must be measurably positive with the:

[(i) Critical engine inoperative and its propeller in the minimum drag position;

[(ii) Remaining engine(s) at takeoff power;

[(iii) Landing gear retracted;

[(iv) Wing flaps in the takeoff position(s); and

[(v) Climb speed equal to that achieved at 50 feet in the demonstration of 523.53.

(2) [The steady gradient of climb must not be less than 0.75 percent at an altitude of 1,500 feet above the takeoff surface, or landing surface, as appropriate, with the:

(i) [Critical engine inoperative and its propeller in the minimum drag position;

(ii) [Remaining engine(s) at not more than maximum continuous power;

[(iii) Landing gear retracted;

[(iv) Wing flaps retracted; and

[(v) Climb speed not less than 1.2 V_{S1}.

(c) [For commuter category aeroplanes, the following apply:

(1) [*Takeoff; landing gear extended.* The steady gradient of climb at the altitude of the takeoff surface must be measurably positive for two-engine aeroplanes, not less than 0.3 percent for three-engine aeroplanes, or 0.5 percent for four-engine aeroplanes with:

[(i) The critical engine inoperative and its propeller in the position it rapidly and automatically assumes;

[(ii) The remaining engine(s) at takeoff power;

[(iii) The landing gear extended, and all landing gear doors open;

[(iv) The wing flaps in the takeoff position(s);

[(v) The wings level; and

[(vi) A climb speed equal to V_2.

(2) [*Takeoff; landing gear retracted.* The steady gradient of climb at an altitude of 400 feet above the takeoff surface must be not less than 2.0 percent for two-engine aeroplanes, 2.3 percent for three-engine aeroplanes, and 2.6 percent for four-engine aeroplanes with:

(i) [The critical engine inoperative and its propeller in the position it rapidly and automatically assumes;

(ii) [The remaining engine(s) at takeoff power;

[(iii) The landing gear retracted;

[(iv) The wing flaps in the takeoff position(s);

[(v) A climb speed equal to V_2.

(3) [*Enroute*. The steady gradient of climb at an altitude of 1,500 feet above the take-off or landing surface, as appropriate, must be not less than 1.2 percent for two-engine aeroplanes, 1.5 percent for three-engine aeroplanes, and 1.7 percent for four-engine aeroplanes with:

[(i) The critical engine inoperative and its propeller in the minimum drag position;

[(ii) The remaining engine(s) at not more than maximum continuous power;

[(iii) The landing gear retracted;

[(iv) The wing flaps retracted; and

[(v) A climb speed not less than 1.2 V_{S1}.

[(4) *Discontinued approach.* The steady gradient of climb at an altitude of 400 feet above the landing surface must be not less than 2.1 percent for two-engine aeroplanes, 2.4 percent for three-engine aeroplanes, and 2.7 percent for four-engine aeroplanes, with:

[(i) The critical engine inoperative and its propeller in the minimum drag position;

[(ii) The remaining engine(s) at takeoff power;

[(iii) Landing gear retracted;

[(iv) Wing flaps in the approach position(s) in which V_{S1} for these position(s) does not exceed 110 percent of the V_{S1} for the related all-engines-operated landing position(s); and

[(v) A climb speed established in connection with normal landing procedures but not exceeding 1.5 V_{S1}.]

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))
(Change 523-4 (96-09-30))
(Change 523-5)

[523.69 *Enroute Climb/Descent*

[(a) *All engines operating*. The steady gradient and rate of climb must be determined at each weight, altitude, and ambient temperature within the operational limits established by the applicant with:

[(1) Not more than maximum continuous power on each engine;

[(2) The landing gear retracted;

[(3) The wing flaps retracted; and

[(4) A climb speed not less than 1.3 V_{S1}.

[(b) *One engine inoperative*. The steady gradient and rate of climb/descent must be determined at each weight, altitude, and ambient temperature within the operational limits established by the applicant with:

[(1) The critical engine inoperative and its propeller in the minimum drag position;

[(2) The remaining engine(s) at not more than maximum continuous power;

[(3) The landing gear retracted;

[(4) The wing flaps retracted; and

[(5) A climb speed not less than 1.2 V_{S1}.]

(Change 523-5)

[523.71 *Glide: Single-Engine Aeroplanes*

[The maximum horizontal distance travelled in still air, in nautical miles, per 1,000 feet of altitude lost in a glide, and the speed necessary to achieve this must be determined with the engine inoperative, its propeller in the minimum drag position, and landing gear and wing flaps in the most favourable available position.]

(Change 523-5)

[523.73 *Reference Landing Approach Speed*

[(a) For normal, utility, and aerobatic category reciprocating engine-powered aeroplanes of 6,000 pounds or less maximum weight, the reference landing approach speed, V_{REF}, must not be less than the greater of V_{MC}, determined in 523.149(b) with the wing flaps in the most extended takeoff position, and 1.3 V_{SO}.

[(b) For normal, utility, and aerobatic category reciprocating engine-powered aeroplanes of more than 6,000 pounds maximum weight, and turbine engine-powered aeroplanes in the normal, utility, and aerobatic category, the reference landing approach speed, V_{REF}, must not be less than the greater of V_{MC}, determined in 523.149(c), and 1.3 V_{SO}.

[(c) For commuter category aeroplanes, the reference landing approach speed, V_{REF}, must not be less than the greater of 1.05 V_{MC}, determined in 523.149(c), and 1.3 V_{SO}.]

(Change 523-5)

523.75 *[Landing Distance*

[The horizontal distance necessary to land and come to a complete stop from a point 50 feet above the landing surface must be determined, for standard temperatures at each weight and altitude within the operational limits established for landing, as follows:

(a) [A steady approach at not less than V_{REF}, determined in accordance with 523.73(a), (b), or (c), as appropriate, must be maintained down to the 50 foot height and:]

(1) The steady approach must be at a gradient of descent not greater than 5.2 percent (3 degrees) down to the 50 foot height.

(2) In addition, an applicant may demonstrate by tests that a maximum steady approach gradient steeper than 5.2 percent, down to the 50 foot height, is safe. The gradient must be established as an operating limitation and the information necessary to display the gradient must be available to the pilot by an appropriate instrument.

(b) [A constant configuration must be maintained throughout the manoeuvre.]

(c) The landing must be made without excessive vertical acceleration or tendency to bounce, nose over, ground loop, porpoise, or water loop.

(d) [It must be shown that a safe transition to the balked landing conditions of 523.77 can be made from the conditions that exist at the 50 foot height, at maximum landing weight, or at the maximum landing weight for altitude and temperature of 523.63 (c)(2) or (d)(2), as appropriate.

(e) [The brakes must be used so as to not cause excessive wear of brakes or tires.

(f) [Retardation means other than wheel brakes may be used if that means:

(1) [Is safe and reliable; and

(2) [Is used so that consistent results can be expected in service.]

(g) If any device is used that depends on the operation of any engine, and the landing distance would be increased when a landing is made with that engine inoperative, the landing distance must be determined with that engine inoperative unless the use of other compensating means will result in a landing distance not more than that with each engine operating.

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))
(Change 523-5)

523.77 *Balked Landing*

(a) [Each normal, utility, and aerobatic category reciprocating engine-powered aeroplane of 6,000 pounds or less maximum weight must be able to maintain a steady gradient of climb at sea level of at least 3.3 percent with:

(1) [Takeoff power on each engine;

(2) [The landing gear extended;

(3) [The wing flaps in the landing position, except that if the flaps may safely be retracted in two seconds or less without loss of altitude and without sudden changes of angle of attack, they may be retracted; and

[(4) A climb speed equal to V_{REF}, as defined in 523.73(a).

(b) [Each normal, utility, and aerobatic category reciprocating engine-powered aeroplane of more than 6,000 pounds maximum weight and each normal, utility, and aerobatic category turbine engine-powered aeroplane must be able to maintain a steady gradient of climb of at least 2.5 percent with:

[(1) Not more than the power that is available on each engine eight seconds after initiation of movement of the power controls from minimum flight-idle position;

[(2) The landing gear extended;

[(3) The wing flaps in the landing position; and

[(4) A climb speed equal to V_{REF}, as defined in 523.73(b).

(c) [Each commuter category aeroplane must be able to maintain a steady gradient of climb of at least 3.2 percent with:

(1) [Not more than the power that is available on each engine eight seconds after initiation of movement of the power controls from the minimum flight idle position;

(2) [Landing gear extended;

[(3) Wing flaps in the landing position; and

[(4) A climb speed equal to V_{REF}, as defined in 523.73(c).]

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))
(Change 523-5)

Flight Characteristics

523.141 *General*

The aeroplane must meet the requirements of 523.143 through 523.253 at all practical loading conditions and operating altitudes for which certification has been requested, not exceeding the maximum operating altitude established under 523.1527, and without requiring exceptional piloting skill, alertness, or strength.

(Change 523-4 (96-09-01))

Controllability and Manoeuvrability

523.143 *General*

(a) [The aeroplane must be safely controllable and manoeuvrable during all flight phases including:

(1) [Takeoff;

(2) [Climb;

(3) [Level flight;

(4) [Descent;

(5) [Go-around; and

[(6) Landing (power on and power off) with the wing flaps extended and retracted.]

(b) It must be possible to make a smooth transition from one flight condition to another (including turns and slips) without danger of exceeding the limit load factor, under any probable operating condition, (including, for multi-engine aeroplanes, those conditions normally encountered in the sudden failure of any engine).

(c) [If marginal conditions exist with regard to required pilot strength, the control forces necessary must be determined by quantitative tests. In no case may the control forces under the conditions specified in paragraphs (a) and (b) of this section exceed those prescribed in Table below:]

[Values In Pounds Force Applied To The Relevant Control]	*Pitch*	*Roll*	*Yaw*
(a) For temporary application:			
Stick	60	30	....
Wheel (two hands on rim)	75	[50]	....
Wheel (one hand on rim)	50	[25]	....
Rudder pedal	....	....	150
(b) For prolonged application:	10	5	20

(Change 523-4 (96-09-01))
(Change 523-5)

523.145 *Longitudinal Control*

(a) With the aeroplane as nearly as possible in trim at 1.3 V_{S1}, it must be possible, at speeds below the trim speed, to pitch the nose downward so that the rate of increase in airspeed allows prompt acceleration to the trim speed with:

(1) Maximum continuous power on each engine;

(2) Power off; and

(3) Wing flap and landing gear:

(i) retracted, and

(ii) extended.

(b) [Unless otherwise required, it must be possible to carry out the following manoeuvres without requiring the application of single-handed control forces exceeding those specified in 523.143(c). The trimming controls must not be adjusted during the manoeuvres:]

(1) With the landing gear extended, the flaps retracted, and the aeroplane as nearly as possible in trim at 1.4 V_{S1}, extend the flaps as rapidly as possible and allow the airspeed to transition from 1.4 V_{S1} to 1.4 V_{SO}:

(i) With power off; and

(ii) With the power necessary to maintain level flight in the initial condition.

(2) [With landing gear and flaps extended, power off, and the aeroplane as nearly as possible in trim at 1.3 V_{SO}, quickly apply takeoff power and retract the flaps as rapidly as possible to the recommended go around setting and allow the airspeed to transition from 1.3 V_{SO} to 1.3 V_{S1}. Retract the gear when a positive rate of climb is established.

(3) [With landing gear and flaps extended, in level flight, power necessary to attain level flight at 1.1 V_{SO}, and the aeroplane as nearly as possible in trim, it must be possible to maintain approximately level flight while retracting the flaps as rapidly as possible with simultaneous application of not more than maximum continuous power.

If gated flap positions are provided, the flap retraction may be demonstrated in stages with power and trim reset for level flight at 1.1 V_{S1}, in the initial configuration for each stage:

[(i) From the fully extended position to the most extended gated position;

[(ii) Between intermediate gated positions, if applicable; and

[(iii) From the least extended gated position to the fully retracted position.

(4) [With power off, flaps and landing gear retracted and the aeroplane as nearly as possible in trim at 1.4 V_{S1}, apply takeoff power rapidly while maintaining the same airspeed.

(5) [With power off, landing gear and flaps extended, and the aeroplane as nearly as possible in trim at V_{REF}, obtain and maintain airspeeds between 1.1 V_{SO} and either 1.7 V_{SO} or V_{FE}, whichever is lower without requiring the application of two-handed control forces exceeding those specified in 523.143(c).

[(6) With maximum takeoff power, landing gear retracted, flaps in the takeoff position, and the aeroplane as nearly as possible in trim at V_{FE} appropriate to the take-off flap position, retract the flaps as rapidly as possible while maintaining constant speed.

(c) [At speeds above V_{MO}/M_{MO}, and up to the maximum speed shown under 523.251, a manoeuvring capability of 1.5g must be demonstrated to provide a margin to recover from upset or inadvertent speed increase.

(d) [It must be possible, with a pilot control force of not more than 10 pounds, to maintain a speed of not more than V_{REF} during a power-off glide with landing gear and wing flaps extended, for any weight of the aeroplane, up to and including the maximum weight.]

(e) By using normal flight and power controls, except as otherwise noted in paragraphs (e)(1) and (e)(2) of this section, it must be possible to establish a zero rate of descent at an attitude suitable for a controlled landing without exceeding the operational and structural limitations of the aeroplane, as follows:

(1) For single-engine and multi-engine aeroplanes, without the use of the primary longitudinal control system.

(2) For multi-engine aeroplanes:

(i) Without the use of the primary directional control; and

(ii) If a single failure of any one connecting or transmitting link would affect both the longitudinal and directional primary control system, without the primary longitudinal and directional control system.

(Change 523-1 (88-01-02))
(Change 523-4 (96-09-01))
(Change 523-5)

523.147 *Directional and Lateral Control*

(a) [For each multi-engine aeroplane, it must be possible, while holding the wings level within 5 degrees, to make sudden changes in heading safely in both directions. This ability must be shown at 1.4 V_{S1} with heading changes up to 15 degrees, except that the heading change at which the rudder force corresponds to the limits specified in 523.143 need not be exceeded, with the:

[(1) Critical engine inoperative and its propeller in the minimum drag position;

[(2) Remaining engines at maximum continuous power;

[(3) Landing gear:

[(i) Retracted, and

[(ii) Extended; and

[(4) Flaps retracted.

(b) [For each multi-engine aeroplane, it must be possible to regain full control of the aeroplane without exceeding a bank angle of 45 degrees, reaching a dangerous attitude or encountering dangerous characteristics, in the event of a sudden and complete failure of the critical engine, making allowance for a delay of two seconds in the initiation of recovery action appropriate to the situation, with the aeroplane initially in trim, in the following condition:

[(1) Maximum continuous power on each engine;

[(2) The wing flaps retracted;

[(3) The landing gear retracted;

[(4) A speed equal to that at which compliance with 523.69(a) has been shown; and

[(5) All propeller controls in the position at which compliance with 523.69(a) has been shown.

[(c) For all aeroplanes, it must be shown that the aeroplane is safely controllable without the use of the primary lateral control system in any all-engine configuration(s) and at any speed or altitude within the approved operating envelope. It must also be shown that the aeroplane's flight characteristics are not impaired below a level needed to permit continued safe flight and the ability to maintain attitudes suitable for a controlled landing without exceeding the operational and structural limitations of the aeroplane. If a single failure of any one connecting or transmitting link in the lateral control system would also cause the loss of additional control system(s), compliance with the above requirement must be shown with those additional systems also assumed to be inoperative.]

(Change 523-4 (96-09-30))
(Change 523-5)

523.149 *Minimum Control Speed*

(a) [V_{MC} is the calibrated airspeed at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane with that engine still inoperative, and thereafter maintain straight flight at the same speed with an angle of bank

of not more than 5 degrees. The method used to simulate critical engine failure must represent the most critical mode of powerplant failure expected in service with respect to controllability.

(b) [V_{MC} for takeoff must not exceed 1.2 V_{S1}, where V_{S1} is determined at the maximum takeoff weight. V_{MC} must be determined with the most unfavourable weight and centre of gravity position and with the aeroplane airborne and the ground effect negligible, for the takeoff configuration(s) with:

(1) [Maximum available takeoff power initially on each engine;

(2) [The aeroplane trimmed for takeoff;

(3) [Flaps in the takeoff position(s);

(4) [Landing gear retracted; and

(5) [All propeller controls in the recommended takeoff position throughout.

(c) [For all aeroplanes except reciprocating engine-powered aeroplanes of 6,000 pounds or less maximum weight, the conditions of paragraph (a) of this section must also be met for the landing configuration with:

[(1) Maximum available takeoff power initially on each engine;

[(2) The aeroplane trimmed for an approach, with all engines operating, at V_{REF}, at an approach gradient equal to the steepest used in the landing distance demonstration of 523.75;

[(3) Flaps in the landing position;

[(4) Landing gear extended; and

[(5) All propeller controls in the position recommended for approach with all engines operating.

(d) [A minimum speed to intentionally render the critical engine inoperative must be established and designated as the safe, intentional, one-engine-inoperative speed, V_{SSE}.

[(e) At V_{MC}, the rudder pedal force required to maintain control must not exceed 150 pounds and it must not be necessary to reduce power of the operative engine(s). During the manoeuvre, the aeroplane must not assume any dangerous attitude and it must be possible to prevent a heading change of more than 20 degrees.

[(f) At the option of the applicant, to comply with the requirements of 523.51(c)(1), V_{MCG} may be determined. V_{MCG} is the minimum control speed on the ground, and is the calibrated airspeed during the takeoff run at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane using the rudder control alone (without the use of nosewheel steering), as limited by 150 pounds of force, and using the lateral control to the extent of keeping the wings level to enable the takeoff to be safely continued. In the determination of V_{MCG}, assuming that the path of the aeroplane accelerating with all engines operating is along the centreline of the runway, its path from the point at which the critical engine is made inoperative to the point at which recovery to a direction parallel to the centreline is completed may not deviate more than 30 feet laterally from the centreline at any point. V_{MCG} must be established with:

[(1) The aeroplane in each takeoff configuration or, at the option of the applicant, in the most critical takeoff configuration;

[(2) Maximum available takeoff power on the operating engines;

[(3) The most unfavourable centre of gravity;

[(4) The aeroplane trimmed for takeoff; and

[(5) The most unfavourable weight in the range of takeoff weights.]

(Change 523-4 (96-09-01))
(Change 523-5)

523.151 *Aerobatic Manoeuvres*

Each aerobatic and utility category aeroplane must be able to perform safely the aerobatic manoeuvres for which certification is requested. Safe entry speeds for these manoeuvres must be determined.

523.153 *Control During Landings*

[It must be possible, while in the landing configuration, to safely complete a landing without exceeding the one-hand control force limits specified in 523.143(c) following an approach to land:

(a) [At a speed of V_{REF} minus 5 knots;

(b) [With the aeroplane in trim, or as nearly as possible in trim and without the trimming control being moved throughout the manoeuvre;

(c) [At an approach gradient equal to the steepest used in the landing distance demonstration of 523.75; and

[(d) With only those power changes, if any, that would be made when landing normally from an approach at V_{REF}.]

(Change 523-4 (96-09-01))
(Change 523-5)

523.155 *Elevator Control Force in Manoeuvres*

(a) The elevator control force needed to achieve the positive manoeuvring load factor may not be less than:

(1) For wheel controls, W/100 (where W is the maximum weight) or 20 pounds, whichever is greater, except that it need not be greater than 50 pounds; or

(2) For stick controls, W/140 (where W is the maximum weight) or 15 pounds, whichever is greater, except that it need not be greater than 35 pounds.

(b) [The requirement of paragraph (a) of this section must be met at 75 percent of maximum continuous power for reciprocating engines, or the maximum continuous power for turbine engines, and with the wing flaps and landing gear retracted:

(1) [In a turn, with the trim setting used for wings level flight at V_O; and]

(2) In a turn with the trim setting used for the maximum wings level flight speed, except that the speed may not exceed V_{NE} or V_{MO}/M_{MO}, whichever is appropriate.

(c) [There must be no excessive decrease in the gradient of the curve of stick force versus manoeuvring load factor with increasing load factor.]

(Change 523-4 (96-09-01))
(Change 523-5)

523.157 *Rate of Roll*

(a) *Takeoff*. It must be possible, using a favourable combination of controls, to roll the aeroplane from a steady 30-degree banked turn through an angle of 60 degrees, so as to reverse the direction of the turn within:

(1) For an aeroplane of 6,000 pounds or less maximum weight, 5 seconds from initiation of roll; and

(2) For an aeroplane of over 6,000 pounds maximum weight, (W + 500)/1,300 seconds but not more than 10 seconds where W is the weight in pounds.

(b) The requirement of paragraph (a) of this section must be met when rolling the aeroplane in each direction with:

(1) Flaps in the takeoff position;

(2) Landing gear retracted;

(3) For a single-engine aeroplane, at maximum takeoff power; and for a multi-engine aeroplane with the critical engine inoperative and the propeller in the minimum drag position, and the other engines at maximum takeoff power; and

(4) The aeroplane trimmed at a speed equal to the greater of 1.2 V_{S1} or 1.1 V_{MC}, or as nearly as possible in trim for straight flight.

(c) *Approach*. It must be possible, using a favourable combination of controls, to roll the aeroplane from a steady 30-degree banked turn through an angle of 60 degrees, so as to reverse the direction of the turn within:

(1) For an aeroplane of 6,000 pounds or less maximum weight, 4 seconds from initiation of roll; and

(2) For an aeroplane of over 6,000 pounds maximum weight, (W + 2,800)/2,200 seconds but not more than 7 seconds where W is the weight in pounds.

(d) [The requirement of paragraph (c) of this section must be met when rolling the aeroplane in each direction in the following conditions:

(1) [Flaps in the landing position(s);

(2) [Landing gear extended;

(3) [All engines operating at the power for a 3 degree approach; and

(4) [The aeroplane trimmed at V_{REF}.]

(Change 523-4 (96-09-01))
(Change 523-5)

Trim

523.161 *Trim*

(a) [*General.* Each aeroplane must meet the trim requirements of this section after being trimmed and without further pressure upon, or movement of, the primary controls or their corresponding trim controls by the pilot or the automatic pilot. In addition, it must be possible, in other conditions of loading, configuration, speed and power to ensure that the pilot will not be unduly fatigued or distracted by the need to apply residual control forces exceeding those for prolonged application of 523.143(c). This applies in normal operation of the aeroplane and, if applicable, to those conditions associated with the failure of one engine for which performance characteristics are established.]

(b) *Lateral and directional trim.* The aeroplane must maintain lateral and directional trim in level flight with the landing gear and wing flaps retracted as follows:

(1) [For normal, utility, and aerobatic category aeroplanes, at a speed of 0.9 V_H, V_C, or V_{MO}/M_{MO}, whichever is lowest; and

(2) [For commuter category aeroplanes, at all speeds from 1.4 V_{S1} to the lesser of V_H or V_{MO}/M_{MO}.

(c) [*Longitudinal trim.* The aeroplane must maintain longitudinal trim under each of the following conditions:

(1) [A climb with:

(i) [Takeoff power, landing gear retracted, wing flaps in the takeoff position(s), at the speeds used in determining the climb performance required by 523.65; and

(ii) [Maximum continuous power at the speeds and in the configuration used in determining the climb performance required by 523.69(a).

(2) [Level flight at all speeds from the lesser of V_H and either V_{NO} or V_{MO}/M_{MO} (as appropriate), to 1.4 V_{S1}, with the landing gear and flaps retracted.

(3) [A descent at V_{NO} or V_{MO}/M_{MO}, whichever is applicable, with power off and with the landing gear and flaps retracted.

(4) [Approach with landing gear extended and with:

[(i) A 3 degree angle of descent, with flaps retracted and at a speed of 1.4 V_{S1};

[(ii) A 3 degree angle of descent, flaps in the landing position(s) at V_{REF}; and

[(iii) An approach gradient equal to the steepest used in the landing distance demonstrations of 523.75, flaps in the landing position(s) at V_{REF}.

(d) [In addition, each multiple aeroplane must maintain longitudinal and directional trim, and the lateral control force must not exceed 5 pounds at the speed used in complying with 523.67(a), (b)(2), or (c)(3), as appropriate, with:]

(1) The critical engine inoperative and if applicable, its propeller in the minimum drag position.

(2) The remaining engines at maximum continuous power;

(3) The landing gear retracted;

(4) [Wing flaps retracted; and]

(5) An angle of bank of not more than 5°.

[(e) In addition, each commuter category aeroplane for which, in the determination of the takeoff path in accordance with 523.57, the climb in the takeoff configuration at V_2 extends beyond 400 feet above the takeoff surface, it must be possible to reduce the longitudinal and lateral control forces to 10 pounds and 5 pounds, respectively, and the directional control force must not exceed 50 pounds at V_2 with:

[(1) The critical engine inoperative and its propeller in the minimum drag position;

[(2) The remaining engine(s) at takeoff power;

[(3) Landing gear retracted;

[(4) Wing flaps in the takeoff position(s); and

[(5) An angle of bank not exceeding 5 degrees.]

(Change 523-3 (92-01-02))
(Change 523-5)

Stability

523.171 *General*

The aeroplane must be longitudinally, directionally, and laterally stable under 523.173 through 523.181. In addition the aeroplane must show suitable stability and control "feel" (static stability) in any condition normally encountered in service, if flight tests show it is necessary for safe operation.

523.173 *Static Longitudinal Stability*

Under the conditions specified in 523.175 and with the aeroplane trimmed as indicated, the characteristics of the elevator control forces and the friction within the control system must be as follows:

(a) A pull must be required to obtain and maintain speeds below the specified trim speed and a push required to obtain and maintain speeds above the specified trim speed. This must be shown at any speed that can be obtained, except that speeds requiring a control force in excess of 40 pounds or speeds above the maximum allowable speed or below the minimum speed for steady unstalled flight, need not be considered.

(b) The airspeed must return to within the tolerances specified for applicable categories of aeroplanes when the control force is slowly released at any speed within the speed range specified in paragraph (a) of this section. The applicable tolerances are:

(1) The airspeed must return to within plus or minus 10 percent of the original trim airspeed; and

(2) For commuter category aeroplanes, the airspeed must return to within plus or minus 7.5 percent of the original trim airspeed for the cruising condition specified in 523.175(b).

(c) The stick force must vary with speed so that any substantial speed change results in a stick force clearly perceptible to the pilot.

(Change 523-1 (88-01-01))

523.175 *Demonstration of Static Longitudinal Stability*

Static longitudinal stability must be shown as follows:

(a) *Climb.* The stick force curve must have a stable slope at speeds between 85 and 115 percent of the trim speed, with:

(1) [Flaps retracted;

(2) [Landing gear retracted;

(3) [Maximum continuous power; and

(4) [The aeroplane trimmed at the speed used in determining the climb performance required by 523.69(a).

(b) [*Cruise.* With flaps and landing gear retracted and the aeroplane in trim with power for level flight at representative cruising speeds at high and low altitudes, including speeds up to V_{NO} or V_{MO}/M_{MO}, as appropriate, except that the speed need not exceed V_H:

(1) [For normal, utility, and aerobatic category aeroplanes, the stick force curve must have a stable slope at all speeds within a range that is the greater of 15 percent of the trim speed plus the resulting free return speed range, or 40 knots plus the resulting free return speed range, above and below the trim speed, except that the slope need not be stable:

(i) [At speeds less than 1.3 V_{S1}; or

(ii) [For aeroplanes with V_{NE} established under 523.1505(a), at speeds greater than V_{NE}; or

(iii) [For aeroplanes with V_{MO}/M_{MO} established under 523.1505(c), at speeds greater than V_{FC}/M_{FC}; or

(2) [For commuter category aeroplanes, the stick force curve must have a stable slope at all speeds within a range of 50 knots plus the resulting free return speed range, above and below the trim speed, except that the slope need not be stable:

(i) [At speeds less than 1.4 V_{S1} or

(ii) [At speeds greater than V_{FC}/M_{FC}; or

(iii) [At speeds that require a stick force greater than 50 pounds.

(c) [*Landing*. The stick force curve must have a stable slope at speeds between 1.1 V_{S1} and 1.8 V_{S1} with:

(1) [Flaps in the landing position;

(2) [Landing gear extended; and

(3) [The aeroplane trimmed at:

[(i) V_{REF}, or the minimum trim speed if higher, with power off; and

[(ii) V_{REF} with enough power to maintain a 3 degree angle of descent.]

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

523.177 *Static Directional and Lateral Stability*

(a) [The static directional stability, as shown by the tendency to recover from a wings level sideslip with the rudder free, must be positive for any landing gear and flap position appropriate to the takeoff, climb, cruise, approach, and landing configurations. This must be shown with symmetrical power up to maximum continuous power, and at speeds from 1.2 V_{S1} up to the maximum allowable speed for the condition being investigated. The angle of sideslip for these tests must be appropriate to the type of aeroplane. At larger angles of sideslip, up to that at which full rudder is used or a control force limit in 523.143 is reached, whichever occurs first, and at speeds from 1.2 V_{S1} to V_O, the rudder pedal force must not reverse.

(b) [The static lateral stability, as shown by the tendency to raise the low wing in a sideslip, must be positive for all landing gear and flap positions. This must be shown with symmetrical power up to 75 percent of maximum continuous power at speeds above 1.2 V_{S1} in the takeoff configuration(s) and at speeds above 1.3 V_{S1} in other configurations, up to the maximum allowable speed for the configuration being investigated, in the takeoff, climb, cruise, and approach configurations. For the landing configuration, the power must be that necessary to maintain a 3 degree angle of descent in co-ordinated flight. The static lateral stability must not be negative at 1.2 V_{S1} in the takeoff configuration, or at 1.3 V_{S1} in other configurations. The angle of sideslip for these tests must be appropriate to the type of aeroplane, but in no case may the constant heading sideslip angle be less than that obtainable with a 10 degree bank, or if less, the maximum bank angle obtainable with full rudder deflection or 150 pound rudder force.

[(c) Paragraph (b) of this section does not apply to aerobatic category aeroplanes certificated for inverted flight.

[(d) In straight, steady slips at 1.2 V_{S1} for any landing gear and flap positions, and for any symmetrical power conditions up to 50 percent of maximum continuous power, the aileron and rudder control movements and forces must increase steadily, but not necessarily in constant proportion, as the angle of sideslip is increased up to the maximum appropriate to the type of aeroplane. At larger slip angles, up to the angle at which full rudder or aileron control is used or a control force limit contained in 523.143 is reached, the aileron and rudder control movements and forces must not reverse as the angle of

sideslip is increased. Rapid entry into, and recovery from, a maximum sideslip considered appropriate for the aeroplane must not result in uncontrollable flight characteristics.

(Change 523-4 (96-09-01))
(Change 523-5)

523.179 *Instrumented Stick Force Measurements (Removed)*

(Change 523-4 (96-09-01))

523.181 *Dynamic Stability*

(a) Any short period oscillation not including combined lateral-directional oscillations occurring between the stalling speed and the maximum allowable speed appropriate to the configuration of the aeroplane must be heavily damped with the primary controls:

(1) Free; and

(2) In a fixed position.

(b) Any combined lateral-directional oscillations ("Dutch roll") occurring between the stalling speed and the maximum allowable speed appropriate to the configuration of the aeroplane must be damped to 1/10 amplitude in 7 cycles with the primary controls:

(1) Free; and

(2) In a fixed position.

(c) If it is determined that the function of a stability augmentation system, reference 523.672, is needed to meet the flight characteristic requirements of this chapter, the primary control requirements of paragraphs (a)(2) and (b)(2) of this section are not applicable to the tests needed to verify the acceptability of that system.

(d) During the conditions as specified in 523.175, when the longitudinal control force required to maintain speeds differing from the trim speed by at least plus and minus 15 percent is suddenly released, the response of the aeroplane must not exhibit any dangerous characteristics nor be excessive in relation to the magnitude of the control force released. Any long-period oscillation of flight path, phugoid oscillation, that results must not be so unstable as to increase the pilot's workload or otherwise endanger the aeroplane.

(Change 523-4 (96-09-01))

Stalls

523.201 *Wings Level Stall*

(a) It must be possible to produce and to correct roll by unreversed use of the rolling control and to produce and to correct yaw by unreversed use of the directional control, up to the time the aeroplane stalls.

(b) The wings level stall characteristics must be demonstrated in flight as follows. Starting from a speed at least 10 knots above the stall speed, the elevator control must be pulled

back so that the rate of speed reduction will not exceed one knot per second until a stall is produced, as shown by either:

(1) An uncontrollable downward pitching motion of the aeroplane;

(2) A downward pitching motion of the aeroplane that results from the activation of a stall avoidance device (for example, stick pusher); or

(3) The control reaching the stop.

(c) Normal use of elevator control for recovery is allowed after the downward pitching motion of paragraphs (b)(1) or (b)(2) of this section has unmistakably been produced, or after the control has been held against the stop for not less than the longer of two seconds or the time employed in the minimum steady flight speed determination of 523.49. (amended 2005/06/03)

(d) During the entry into and the recovery from the manoeuvre, it must be possible to prevent more than 15 degrees of roll or yaw by the normal use of controls.

(e) Compliance with the requirements of this section must be shown under the following conditions:

(1) *Wing flaps.* Retracted, fully extended, and each intermediate normal operating position.

(2) *Landing gear.* Retracted and extended.

(3) *Cowl flaps.* Appropriate to configuration.

(4) *Power*:

(i) Power off; and

(ii) 75 percent of maximum continuous power. However, if the power-to-weight ratio at 75 percent of maximum continuous power result in extreme nose-up attitudes, the test may be carried out with the power required for level flight in the landing configuration at maximum landing weight and a speed of 1.4 V_{SO}, except that the power may not be less than 50 percent of maximum continuous power.

(5) *Trim.* The aeroplane trimmed at a speed as near 1.5 V_{S1} as practicable.

(6) *Propeller.* Full increase r.p.m.. position for the power off condition.

(Change 523-4 (96-09-01))
(Change 523-5)

523.203 *Turning Flight and Accelerated Turning Stalls*

Turning flight and accelerated turning stalls must be demonstrated in tests as follows:

(a) Establish and maintain a co-ordinated turn in a 30 degree bank. Reduce speed by steadily and progressively tightening the turn with the elevator until the aeroplane is stalled, as defined in 523.201(b). The rate of speed reduction must be constant, and:

(1) For a turning flight stall, may not exceed one knot per second; and

(2) For an accelerated turning stall, be 3 to 5 knots per second with steadily increasing normal acceleration.

(b) [After the aeroplane has stalled, as defined in 523.201(b), it must be possible to regain wings level flight by normal use of the flight controls, but without increasing power and without:]

(1) Excessive loss of altitude;

(2) Undue pitch-up;

(3) Uncontrollable tendency to spin;

(4) [Exceeding a bank angle of 60 degrees in the original direction of the turn or 30 degrees in the opposite direction in the case of turning flight stalls;

(5) [Exceeding a bank angle of 90 degrees in the original direction of the turn or 60 degrees in the opposite direction in the case of accelerated turning stalls; and

[(6) Exceeding the maximum permissible speed or allowable limit load factor.

(c) [Compliance with the requirements of this section must be shown under the following conditions:

(1) [*Wing flaps*: Retracted, fully extended, and each intermediate normal operating position;]

(2) *Landing Gear*: Retracted and extended;

(3) *Cowl Flaps*: Appropriate to configuration;

(4) [*Power*:

[(i) Power off; and

[(ii) 75 percent of maximum continuous power. However, if the power-to-weight ratio at 75 percent of maximum continuous power results in extreme nose-up attitudes, the test may be carried out with the power required for level flight in the landing configuration at maximum landing weight and a speed of 1.4 V_{SO}, except that the power may not be less than 50 percent of maximum continuous power.]

(5) *Trim*: The aeroplane trimmed at a speed as near 1.5 V_{S1} as practicable.

[(6) *Propeller*. Full increase r.p.m. position for the power off condition.]

(Change 523-4 (96-09-01))
(Change 523-5)

523.205 *Critical Engine Inoperative Stalls [Removed]*

(Change 523-4 (96-09-01))
(Change 523-5)

523.207 *Stall Warning*

(a) There must be a clear and distinctive stall warning, with the flaps and landing gear in any normal position, in straight and turning flight.

(b) The stall warning may be furnished either through the inherent aerodynamic qualities of the aeroplane or by a device that will give clearly distinguishable indications under expected conditions of flight. However, a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself.

(c) [During the stall tests required by 523.201(b) and 523.203(a)(1), the stall warning must begin at a speed exceeding the stalling speed by a margin of not less than 5 knots and must continue until the stall occurs.

(d) [When following procedures furnished in accordance with 523.1585, the stall warning must not occur during a takeoff with all engines operating, a takeoff continued with one-engine-inoperative, or during an approach to landing.

[(e) During the stall tests required by 523.203(a)(2), the stall warning must begin sufficiently in advance of the stall for the stall to be averted by pilot action taken after the stall warning first occurs.

[(f) For aerobatic category aeroplanes, an artificial stall warning may be mutable, provided that it is armed automatically during takeoff and rearmed automatically in the approach configuration.]

(Change 523-4 (96-09-01))
(Change 523-5)

Spinning

523.221 *Spinning*

(a) [*Normal category aeroplanes*. A single-engine, normal category aeroplane must be able to recover from a one-turn spin or a three-second spin, whichever takes longer, in not more than one additional turn after initiation of the first control action for recovery, or demonstrate compliance with the optional spin resistant requirements of this section.

(1) [The following apply to one turn or three second spins:

(i) [For both the flaps-retracted and flaps-extended conditions, the applicable airspeed limit and positive limit manoeuvring load factor must not be exceeded;

(ii) [No control forces or characteristic encountered during the spin or recovery may adversely affect prompt recovery;

(iii) [It must be impossible to obtain unrecoverable spins with any use of the flight or engine power controls either at the entry into or during the spin; and

(iv) [For the flaps-extended condition, the flaps may be retracted during the recovery but not before rotation has ceased.

(2) [At the applicant's option, the aeroplane may be demonstrated to be spin resistant by the following:

(i) [During the stall manoeuvre contained in 523.201, the pitch control must be pulled back and held against the stop. Then, using ailerons and rudders in the proper direction, it must be possible to maintain wings-level flight within 15

degrees of bank and to roll the aeroplane from a 30 degree bank in one direction to a 30 degree bank in the other direction;

(ii) [Reduce the aeroplane speed using pitch control at a rate of approximately one knot per second until the pitch control reaches the stop; then, with the pitch control pulled back and held against the stop, apply full rudder control in a manner to promote spin entry for a period of seven seconds or through a 360 degree heading change, whichever occurs first. If the 360 degree heading change is reached first, it must have taken no fewer than four seconds. This manoeuvre must be performed first with the ailerons in the neutral position, and then with the ailerons deflected opposite the direction of turn in the most adverse manner. Power and aeroplane configuration must be set in accordance with 523.201(e) without change during the manoeuvre. At the end of seven seconds or a 360 degree heading change, the aeroplane must respond immediately and normally to primary flight controls applied to regain co-ordinated, unstalled flight without reversal of control effect and without exceeding the temporary control forces specified by 523.143(c); and

(iii) [Compliance with 523.201 and 523.203 must be demonstrated with the aeroplane in uncoordinated flight, corresponding to one ball width displacement on a slip-skid indicator, unless one ball width displacement cannot be obtained with full rudder, in which case the demonstration must be with full rudder applied.

(b) [*Utility category aeroplanes*. A utility category aeroplane must meet the requirements of paragraph (a) of this section. In addition, the requirements of paragraph (c) of this section and 523.807(b)(6) must be met if approval for spinning is requested.

(c) [*Aerobatic category aeroplanes*. An aerobatic category aeroplane must meet the spin requirements of paragraph (a) of this section and 523.807(b)(6). In addition, the following requirements must be met in each configuration for which approval for spinning is requested:

(1) [The aeroplane must recover from any point in a spin up to and including six turns, or any greater number of turns for which certification is requested, in not more than one and one-half additional turns after initiation of the first control action for recovery. However, beyond three turns, the spin may be discontinued if spiral characteristics appear.

(2) [The applicable airspeed limits and limit manoeuvring load factors must not be exceeded. For flaps-extended configurations for which approval is requested, the flaps must not be retracted during the recovery.

(3) [It must be impossible to obtain unrecoverable spins with any use of the flight or engine power controls either at the entry into or during the spin.

[(4) There must be no characteristics during the spin (such as excessive rates of rotation or extreme oscillatory motion) that might prevent a successful recovery due to disorientation or incapacitation of the pilot.]

(Change 523-3 (92-01-02))
(Change 523-5)

Ground and Water Handling Characteristics

523.231 *Longitudinal Stability and Control*

(a) A landplane may have no uncontrollable tendency to nose over in any reasonably expected operating condition, including rebound during landing or takeoff. Wheel brakes must operate smoothly and may not induce any undue tendency to nose over.

(b) A seaplane or amphibian may not have dangerous or uncontrollable porpoising characteristics at any normal operating speed on the water.

523.233 *Directional Stability and Control*

(a) [A 90 degree cross-component of wind velocity, demonstrated to be safe for taxiing, takeoff, and landing must be established and must be not less than 0.2 V_{SO}.]

(b) The aeroplane must be satisfactorily controllable in power-off landings at normal landing speed, without using brakes or engine power to maintain a straight path until the speed has decreased to at least 50 percent of the speed at touchdown.

(c) The aeroplane must have adequate directional control during taxiing.

(d) Seaplanes must demonstrate satisfactory directional stability and control for water operations up to the maximum wind velocity specified in paragraph (a) of this section.

(Change 523-4 (96-09-01))
(Change 523-5)

523.235 *[Operation On Unpaved Surfaces*

[The aeroplane must be demonstrated to have satisfactory characteristics and the shock-absorbing mechanism must not damage the structure of the aeroplane when the aeroplane is taxied on the roughest ground that may reasonably be expected in normal operation and when takeoffs and landings are performed on unpaved runways having the roughest surface that may reasonably be expected in normal operation.]

(Change 523-4 (96-09-01))
(Change 523-5)

[523.237 *Operation On Water*

[A wave height, demonstrated to be safe for operation, and any necessary water handling procedures for seaplanes and amphibians must be established.]

(Change 523-5)

523.239 *Spray Characteristics*

Spray may not dangerously obscure the vision of the pilots or damage the propellers or other parts of a seaplane or amphibian at any time during taxiing, takeoff, and landing.

Miscellaneous Flight Requirements

523.251 *Vibration and Buffeting*

There must be no vibration or buffeting severe enough to result in structural damage, and each part of the aeroplane must be free from excessive vibration, under any appropriate speed and power conditions up to V_D/M_D. In addition, there must be no buffeting in any normal flight condition severe enough to interfere with the satisfactory control of the aeroplane or cause excessive fatigue to the flight crew. Stall warning buffeting within these limits is allowable.

(Change 523-4 (96-09-01))

523.253 *High Speed Characteristics*

If a maximum operating speed V_{MO}/M_{MO} is established under 523.1505(c), the following speed increase and recovery characteristics must be met:

(a) Operating conditions and characteristics likely to cause inadvertent speed increases (including upsets in pitch and roll) must be simulated with the aeroplane trimmed at any likely speed up to V_{MO}/M_{MO}. These conditions and characteristics include gust upsets, inadvertent control movements, low stick force gradients in relation to control friction, passenger movement, levelling off from climb, and descent from Mach to airspeed limit altitude.

(b) Allowing for pilot reaction time after occurrence of the effective inherent or artificial speed warning specified in 523.1303, it must be shown that the aeroplane can be recovered to a normal attitude and its speed reduced to V_{MO}/M_{MO}, without:

[(1)] Exceeding V_D/M_D, the maximum speed shown under 523.251, or the structural limitations; or

[(2)] Buffeting that would impair the pilot's ability to read the instruments or to control the aeroplane for recovery.

(c) There may be no control reversal about any axis at any speed up to the maximum speed shown under 523.251. Any reversal of elevator control force or tendency of the aeroplane to pitch, roll, or yaw must be mild and readily controllable, using normal piloting techniques.

(Change 523-4 (96-09-01))
(Change 523-5)

SUBCHAPTER C

Structure - General

523.301 *Loads*

(a) Strength requirements are specified in terms of limit loads (the maximum loads to be expected in service) and ultimate loads (limit loads multiplied by prescribed factors of safety). Unless otherwise provided, prescribed loads are limit loads.

(b) Unless otherwise provided, the air, ground, and water loads must be placed in equilibrium with inertia forces, considering each item of mass in the aeroplane. These loads must be distributed to conservatively approximate or closely represent actual conditions. Methods used to determine load intensities and distribution on canard and tandem wing configurations must be validated by flight test measurement unless the methods used for determining those loading conditions are shown to be reliable or conservative on the configuration under consideration.

(c) If deflections under load would significantly change the distribution of external or internal loads, this redistribution must be taken into account.

(d) [Simplified structural design criteria may be used if they result in design loads not less than those prescribed in 523.331 through 523.521. For aeroplane configurations described in appendix A, 523.1, the design criteria of appendix A of this chapter are an approved equivalent of 523.321 through 523.459. If appendix A of this chapter is used, the entire appendix must be substituted for the corresponding sections of this chapter].

(Change 523-3 (92-01-02))
(Change 523-5)

523.302 *Canard or Tandem Wing Configurations*

The forward structure of a canard or tandem wing configuration must:

(a) Meet all requirements of subchapter C and subchapter D of this chapter applicable to a wing; and

(b) Meet all requirements applicable to the function performed by these surfaces.

(Change 523-3 (92-01-02))

523.303 *Factor of Safety*

Unless otherwise provided, a factor of safety of 1.5 must be used.

523.305 *Strength and Deformation*

(a) The structure must be able to support limit loads without detrimental, permanent deformation. At any load up to limit loads, the deformation may not interfere with safe operation.

(b) The structure must be able to support ultimate loads without failure for at least three seconds, except local failures or structural instabilities between limit and ultimate load are acceptable only if the structure can sustain the required ultimate load for at least three seconds. However, when proof of strength is shown by dynamic tests simulating actual load conditions, the three second limit does not apply.

(Change 523-4 (96-09-01))

523.307 *Proof of Structure*

(a) Compliance with the strength and deformation requirements of 523.305 must be shown for each critical load condition. Structural analysis may be used only if the structure conforms to those for which experience has shown this method to be reliable. In other cases, substantiating load tests must be made. Dynamic tests, including structural flight tests, are acceptable if the design load conditions have been simulated.

(b) Certain parts of the structure must be tested as specified in Subchapter D of this Chapter.

Flight Loads

523.321 *General*

(a) Flight load factors represent the ratio of the aerodynamic force component (acting normal to the assumed longitudinal axis of the aeroplane) to the weight of the aeroplane. A positive flight load factor is one in which the aerodynamic force acts upward, with respect to the aeroplane.

(b) Compliance with the flight load requirements of this subchapter must be shown:

(1) At each critical altitude within the range in which the aeroplane may be expected to operate;

(2) At each weight from the design minimum weight to the design maximum weight; and

(3) For each required altitude and weight, for any practicable distribution of disposable load within the operating limitations specified in 523.1583 through 523.1589.

(c) When significant, the effects of compressibility must be taken into account.

(Change 523-4 (96-09-01))

523.331 *Symmetrical Flight Conditions*

(a) The appropriate balancing horizontal tail load must be accounted for in a rational or conservative manner when determining the wing loads and linear inertia loads corresponding to any of the symmetrical flight conditions specified in 523.333 through 523.341.

(b) The incremental horizontal tail loads due to manoeuvring and gusts must be reacted by the angular inertia of the aeroplane in a rational or conservative manner.

(c) Mutual influence of the aerodynamic surfaces must be taken into account when determining flight loads.

(Change 523-3 (92-01-02))

523.333 *Flight Envelope*

(a) *General.* Compliance with the strength requirements of this subchapter must be shown at any combination of airspeed and load factor on and within the boundaries of a flight envelope (similar to the one in paragraph (d) of this section) that represents the envelope of the flight loading conditions specified by the manoeuvring and gust criteria of paragraphs (b) and (c) of this section respectively.

(b) *Manoeuvring envelope.* Except where limited by maximum (static) lift coefficients, the aeroplane is assumed to be subjected to symmetrical manoeuvres resulting in the following limit load factors:

(1) The positive manoeuvring load factor specified in 523.337 at speeds up to V_D;

(2) The negative manoeuvring load factor specified in 523.337 at V_C; and

(3) Factors varying linearly with speed from the specified value at V_C to 0.0 at V_D for the normal and commuter category, and -1.0 at V_D for the aerobatic and utility categories.

(c) *Gust* envelope.

(1) The aeroplane is assumed to be subjected to symmetrical vertical gusts in level flight. The resulting limit load factors must correspond to the conditions determined as follows:

(i) Positive (up) and negative (down) gusts of 50 f.p.s. at V_C must be considered at altitudes between sea level and 20,000 feet. The gust velocity may be reduced linearly from 50 f.p.s. at 20,000 feet to 25 f.p.s. at 50,000 feet.

(ii) Positive and negative gusts of 25 f.p.s. at V_D must be considered at altitudes between sea level and 20,000 feet. The gust velocity may be reduced linearly from 25 f.p.s. at 20,000 feet to 12.5 f.p.s. at 50,000 feet.

(iii) In addition, for commuter category aeroplanes, positive (up) and negative (down) rough air gusts of 66 f.p.s. at V_B must be considered at altitudes between sea level and 20,000 feet. The gust velocity may be reduced linearly from 66 f.p.s. at 20,000 feet to 38 f.p.s. at 50,000 feet.

(2) The following assumptions must be made:

(i) The shape of the gust is:

$$U = \frac{U_{de}}{2}\left(1 - \cos\frac{2\pi s}{25\overline{C}}\right)$$

where:

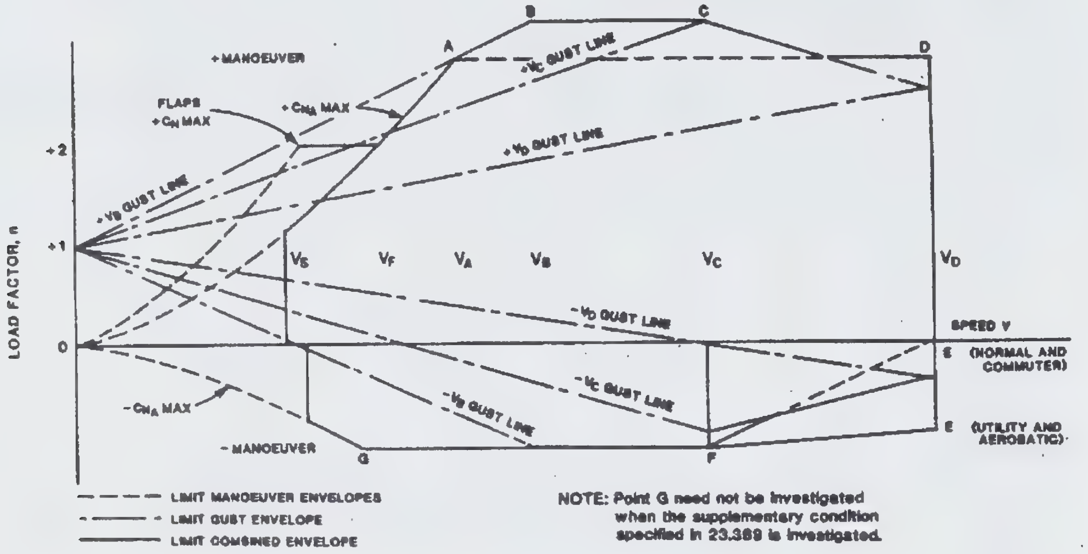
s = Distance penetrated into gust (ft.);

$\overline{C}$ = Mean geometric chord of wing (ft.); and

U_{de} = Derived gust velocity referred to in subparagraph (l) of this section.

(ii) Gust Load factors vary linearly with speed between V_C and V_D.

(d) Flight envelope.



(Change 523-1 (88-01-01))

523.335 *Design Airspeeds*

Except as provided in paragraph (a) (4) of this section, the selected design airspeeds are equivalent airspeeds (EAS).

(a) Design *cruising speed*, V_C. For V_C the following apply:

(1) [Where W/S' = wing loading at the design maximum takeoff weight, V_C (in knots) may not be less than:

(i) [$33\sqrt{(W/S)}$ (for normal, utility, and commuter category aeroplanes);

(ii) [$36\sqrt{(W/S)}$ (for aerobatic category aeroplanes).]

(2) For values of W/S more than 20, the multiplying factors may be decreased linearly with W/S to a value of 28.6 where W/S = 100.

(3) V_C need not be more than 0.9 V_H at sea level.

(4) At altitudes where an M_D is established, a cruising speed M_C limited by compressibility may be selected.

(b) Design *dive speed* V_D. For V_D, the following apply:

(1) V_D/M_D may not be less than 1.25 V_C/M_C; and

(2) With V_C min, the required minimum design cruising speed, V_D (in knots) may not be less than:

(i) 1.40 V_C min (for normal and commuter category aeroplanes);

(ii) 1.50 V_C min (for utility category aeroplanes; and

(iii) 1.55 V_C min (aerobatic category aeroplanes).

(3) For values of W/S more than 20, the multiplying factors in subparagraph (2) of this paragraph may be decreased linearly with W/S to a value of 1.35 where W/S = 100.

(4) Compliance with subparagraphs (1) and (2) of this paragraph need not be shown if V_D/M_D is selected so that the minimum speed margin between V_C/M_C and V_D/M_D is the greater of the following:

(i) The speed increase resulting when, from the initial condition of stabilised flight at V_C/M_C, the aeroplane is assumed to be upset, flown for 20 seconds along a flight path 7.5° below the initial path, and then pulled up with a load factor of 1.5 (0.5 g. acceleration increment). At least 75 percent maximum continuous power for reciprocating engines, and maximum cruising power for turbines, or, if less, the power required for V_C/M_C for both kinds of engines, must be assumed until the pull up is initiated, at which point power reduction and pilot-controlled drag devices may be used; [and either:

(ii) [Mach 0.05 for normal, utility, and aerobatic category aeroplanes (at altitudes where M_D is established); or

[(iii) Mach 0.07 for commuter category aeroplanes (at altitudes where M_D is established) unless a rational analysis, including the effects of automatic systems, is used to determine a lower margin. If a rational analysis is used, the minimum speed margin must be enough to provide for atmospheric variations (such as horizontal gusts), and the penetration of jet streams or cold fronts), instrument errors, airframe production variations, and must not be less than Mach 0.05.]

(c) *Design* manoeuvring *speed* V_A. For V_A the following applies:

(1) V_A may not be less than $V_S \sqrt{n}$,

where:

(i) V_S is a computed stalling speed with flaps retracted at the design weight, normally based on the maximum aeroplane normal force coefficients, C_{NA}; and

(ii) n is the limit manoeuvring load factor used in design.

(2) The value of V_A need not exceed the value of V_C used in design.

(d) Design *speed for maximum gust intensity*, V_B. For V_B, the following apply:

(1) [V_B may not be less than the speed determined by the intersection of the line representing the maximum positive lift $C_{N\ MAX}$, and the line representing the rough air gust velocity on the gust V-n diagram, or $V_{S1} \sqrt{n_g}$, whichever is less, where:]

(i) n_g the positive aeroplane gust load factor due to gust, at speed V_C (in accordance with 523.341), and at the particular weight under consideration; and

(ii) V_{S1} is the stalling speed with the flaps retracted at the particular weight under consideration.

(2) V_B need not be greater than V_C.

(Change 523-1 (88-01-01))
(Change 523-5)

523.337 *Limit Manoeuvring Load Factors*

(a) The positive limit manoeuvring load factor n may not be less than:

(1) [$2.1+\frac{24{,}000}{(W+10{,}000)}$ for normal and commuter category aeroplanes, where

W = design maximum takeoff weight, except that n need not be more than 3.8;]

(2) 4.4 for utility category aeroplanes; or

(3) 6.0 for aerobatic category aeroplanes.

(b) The negative limit manoeuvring load factor may not be less than:

(1) 0.4 times the positive load factor for the normal, utility, and commuter categories; or

(2) 0.5 times the positive load factor for the aerobatic category.

(c) Manoeuvring load factors lower than those specified in this section may be used if the aeroplane has design features that make it impossible to exceed these values in flight.

(Change 523-1 (88-01-01))
(Change 523-5)

523.341 *Gust Loads Factors*

(a) [Each aeroplane must be designed to withstand loads on each lifting surface resulting from gusts specified in 523.333(c).

(b) [The gust load for a canard or tandem wing configuration must be computed using a rational analysis, or may be computed in accordance with paragraph (c) of this section, provided that the resulting net loads are shown to be conservative with respect to the gust criteria of 523.333(c).

[(c) In the absence of a more rational analysis, the gust load factors must be computed as follows:

$$n=1+\frac{K_g U_{de} V_a}{498(W/S)}$$

where:]

$K_g = \dfrac{0.88\mu_g}{5.3 + \mu_g}$ = gust alleviation factor;

$\mu_g = \dfrac{2(W/S)}{\rho Cag}$ = aeroplane mass ratio;

U_{de} = Derived gust velocities referred to in 523.333(c) (f.p.s.);

ρ = Density of air (slugs/cu. ft.);

[W/S = Wing loading (p.s.f.) due to the applicable weight of the aeroplane in the particular load case.]

C= Mean geometric chord (ft.);

g = Acceleration due to gravity (ft/sec.^{2});

V = Aeroplane equivalent speed (knots); and

a = Slope of the aeroplane normal force coefficient curve C_{NA} per radian if the gust loads are applied to the wings and horizontal tail surfaces simultaneously by a rational method. The wing lift curve slope C_L per radian may be used when the gust load is applied to the wings only and the horizontal tail gust loads are treated as a separate condition.

(Change 523-3 (92-01-02))
(Change 523-5)

[523.343 *Design Fuel Loads*

[(a) The disposable load combinations must include each fuel load in the range from zero fuel to the selected maximum fuel load.

[(b) If fuel is carried in the wings, the maximum allowable weight of the aeroplane without any fuel in the wing tank(s) must be established as "maximum zero wing fuel weight," if it is less than the maximum weight.

[(c) For commuter category aeroplanes, a structural reserve fuel condition, not exceeding fuel necessary for 45 minutes of operation at maximum continuous power, may be selected. If a structural reserve fuel condition is selected, it must be used as the minimum fuel weight condition for showing compliance with the flight load requirements prescribed in this chapter and:

[(1) The structure must be designed to withstand a condition of zero fuel in the wing at limit loads corresponding to:

[(i) Ninety percent of the manoeuvring load factors defined in 523.337, and

[(ii) Gust velocities equal to 85 percent of the values prescribed in 523.333(c).

[(2) The fatigue evaluation of the structure must account for any increase in operating stresses resulting from the design condition of paragraph (c)(1) of this section.

[(3) The flutter, deformation, and vibration requirements must also be met with zero fuel in the wings.]

(Change 523-5)

523.345 *High Lift Devices*

(a) [If flaps or similar high lift devices are to be used for takeoff, approach or landing, the aeroplane, with the flaps fully extended at V_F, is assumed to be subjected to symmetrical manoeuvres and gusts within the range determined by:

(1) [Manoeuvring, to a positive limit load factor of 2.0; and

(2) [Positive and negative gust of 25 feet per second acting normal to the flight path in level flight.

(b) [V_F must be assumed to be not less than 1.4 V_S or 1.8 V_{SF}, whichever is greater, where:

[(1) V_S is the computed stalling speed with flaps retracted at the design weight; and

[(2) V_{SF} is the computed stalling speed with flaps fully extended at the design weight.

[(3) If an automatic flap load limiting device is used, the aeroplane may be designed for the critical combinations of airspeed and flap position allowed by that device.

(c) [In determining external loads on the aeroplane as a whole, thrust, slipstream, and pitching acceleration may be assumed to be zero.

(d) [The flaps, their operating mechanism, and their supporting structures, must be designed to withstand the conditions prescribed in paragraph (a) of this section. In addition, with the flaps fully extended at V_F, the following conditions, taken separately, must be accounted for:

[(1) A head-on gust having a velocity of 25 feet per second (EAS), combined with propeller slipstream corresponding to 75 percent of maximum continuous power; and

[(2) The effects of propeller slipstream corresponding to maximum takeoff power.]

(Change 523-5)

523.347 *Unsymmetrical Flight Conditions*

[(a)] The aeroplane is assumed to be subjected to the unsymmetrical flight conditions of 523.349 and 523.351. Unbalanced aerodynamic moments about the centre of gravity must be reacted in a rational or conservative manner, considering the principal masses furnishing the reacting inertia forces.

[(b) Aerobatic category aeroplanes certified for flick manoeuvres (snap roll) must be designed for additional asymmetric loads acting on the wing and the horizontal tail.]

(Change 523-5)

523.349 *Rolling Conditions*

The wing and wing bracing must be designed for the following loading conditions:

(a) Unsymmetrical wing loads appropriate to the category. Unless the following values result in unrealistic loads, the rolling accelerations may be obtained by modifying the symmetrical flight conditions in 523.333(d) as follows:

(1) For the aerobatic category, in conditions A and F, assume that 100 percent of the semispan wing air load acts on one side of the plane of symmetry and 60 percent of this load acts on the other side.

(2) [For normal, utility, and commuter categories, in Condition A, assume that 100 percent of the semispan wing airload acts on one side of the aeroplane and 75 percent of this load acts on the other side.]

(b) The loads resulting from the aileron deflections and speeds specified in 523.455, in combination with an aeroplane load factor of at least two thirds of the positive manoeuvring factor used for design. Unless the following values result in unrealistic loads, the effect of aileron displacement on wing torsion may be accounted for by adding the following increment to the basic airfoil moment coefficient over the aileron portion of the span in the aileron portion of the span in the critical condition determined in 523.333(d):

$\Delta C_m = -0.01\delta$

where:

ΔC_m is the moment coefficient increment; and

δ is the down aileron deflection in degrees in the critical condition.

(Change 523-1 (88-01-01))
(Change 523-5)

523.351 *Yawing Conditions*

The aeroplane must be designed for yawing loads on the vertical surfaces resulting from the loads specified in 523.441 through 523.445.

(Change 523-3 (92-01-02))

523.361 *Engine Torque*

(a) Each engine mount and its supporting structure must be designed for the effects of:

(1) A limit engine torque corresponding to takeoff power and propeller speed acting simultaneously with 75 percent of the limit loads from flight condition A of 523.333(d);

(2) A limit engine torque corresponding to maximum continuous power and propeller speed acting simultaneously with the limit loads from flight condition A of 523.333(d); and

(3) For turbo propeller installations, in addition to the conditions specified in paragraphs (a)(l) and (a)(2) of this section, a limit engine torque corresponding to take-off power and propeller speed, multiplied by a factor accounting for propeller control system malfunction, including quick feathering, acting simultaneously with 1g level flight loads. In the absence of a rational analysis, a factor of 1.6 must be used.

(b) For turbine engine installations, the engine mounts and supporting structure must be designed to withstand each of the following:

(1) A limit engine torque load imposed by sudden engine stoppage due to malfunction or structural failure (such as compressor jamming).

(2) A limit engine torque load imposed by the maximum acceleration of the engine.

(c) The limit engine torque to be considered under paragraph (a) of this section must be obtained by multiplying the mean torque by a factor of:

(1) 1.25 for turbo propeller installations;

(2) 1.33 for engines with five or more cylinders; and

(3) Two, three, or four, for engines with four, three, or two cylinders respectively.

(Change 523-4 (96-09-01))

523.363 *Side Load on Engine Mount*

(a) Each engine mount and its supporting structure must be designed for a limit load factor in a lateral direction, for the side load on the engine mount, of not less than:

(1) 1.33; or

(2) One-third of the limit load factor for flight condition A.

(b) The side load prescribed in paragraph (a) of this section may be assumed to be independent of other flight conditions.

523.365 *Pressurized Cabin Loads*

For each pressurized compartment, the following apply:

(a) The aeroplane structure must be strong enough to withstand the flight loads combined with pressure differential loads from zero up to the maximum relief valve setting.

(b) The external pressure distribution in flight, and any stress concentrations, must be accounted for.

(c) If landings may be made, with the cabin pressurised, landing loads must be combined with pressure differential loads from zero up to the maximum allowed during landing.

(d) The aeroplane structure must be strong enough to withstand the pressure differential loads corresponding to the maximum relief valve setting multiplied by a factor of 1.33, omitting other loads.

(e) If a pressurized cabin has two or more compartments separated by bulkheads or a floor, the primary structure must be designed for the effects of sudden release of pressure in any compartment with external doors or windows. This condition must be investigated for the effects of failure of the largest opening in the compartment. The effects of inter-compartmental venting may be considered.

523.367 *Unsymmetrical Loads Due to Engine Failure*

(a) Turbo propeller aeroplanes must be designed for the unsymmetrical loads resulting from the failure of the critical engine including the following conditions in combination with a single malfunction of the propeller drag limiting system, considering the probable pilot corrective action on the flight controls:

(1) At speeds between V_{MC} and V_D, the loads resulting from power failure because of fuel flow interruption are considered to be limit loads.

(2) At speeds between V_{MC} and V_C, the loads resulting from the disconnection of the engine compressor from the turbine or from loss of the turbine blades are considered to be ultimate loads.

(3) The time history of the thrust decay and drag build-up occurring as a result of the prescribed engine failures must be substantiated by test or other data applicable to the particular engine-propeller combination.

(4) The timing and magnitude of the probable pilot corrective action must be conservatively estimated, considering the characteristics of the particular engine-propeller-aeroplane combination.

(b) Pilot corrective action may be assumed to be initiated at the time maximum yawing velocity is reached, but not earlier than 2 seconds after the engine failure. The magnitude of the corrective action may be based on the limit pilot forces specified in 523.397 except that lower forces may be assumed where it is shown by analysis or test that these forces can control the yaw and roll resulting from the prescribed engine failure conditions.

523.369 *Rear Lift Truss*

(a) [If a rear lift truss is used, it must be designed to withstand conditions of reversed airflow at a design speed of:

$$V = 8.7\sqrt{(W/S)} + 8.7(knots)$$

where:

W/S = wing loading at design maximum takeoff weight.]

(b) Either aerodynamic data for the particular wing section used, or a value of C_L equalling -0.8 with a chord wise distribution that is triangular between a peak at the trailing edge and zero at the leading edge, must be used.

(Change 523-4 (96-09-01))
(Change 523-5)

523.371 *Gyroscopic and Aerodynamic Loads*

(a) [Each engine mount and its supporting structure must be designed for the gyroscopic, inertial, and aerodynamic loads that result, with the engine(s) and propeller(s), if applicable, at maximum continuous rpm, under either:

[(1) The conditions prescribed in 523.351 and 523.423; or

[(2) All possible combinations of the following:

[(i) A yaw velocity of 2.5 radians per second;

[(ii) A pitch velocity of 1.0 radian per second;

[(iii) A normal load factor of 2.5; and

[(iv) Maximum continuous thrust.

(b) [For aeroplanes approved for aerobatic manoeuvres, each engine mount and its supporting structure must meet the requirements of paragraph (a) of this section and be designed to withstand the load factors expected during combined maximum yaw and pitch velocities.

[(c) For aeroplanes certificated in the commuter category, each engine mount and its supporting structure must meet the requirements of paragraph (a) of this section and the gust conditions specified in 523.341 of this chapter.]

(Change 523-4 (96-09-01))
(Change 523-5)

523.373 *Speed Control Devices*

If speed control devices (such as spoilers and drag flaps) are incorporated for use in en route conditions:

(a) The aeroplane must be designed for the symmetrical manoeuvres and gusts prescribed in 523.333, 523.337, and 523.341, and the yawing manoeuvres and lateral gusts in 523.441 and 523.443, with the device extended at speeds up to the placard device extended speed; and

(b) If the device has automatic operating or load limiting features, the aeroplane must be designed for the manoeuvre and gust conditions prescribed in paragraph (a) of this section at the speeds and corresponding device positions that the mechanism allows.

Control Surface and System Loads

523.391 *Control Surface Loads*

The control surface loads specified in 523.397 through 523.459 are assumed to occur in the conditions described in 523.331 through 523.351.

(b) [Removed]

(Change 523-3 (92-01-02))
(Change 523-5)

[523.393 *Loads Parallel To Hinge Line*

[(a) Control surfaces and supporting hinge brackets must be designed to withstand inertial loads acting parallel to the hinge line.

[(b) In the absence of more rational data, the inertial loads may be assumed to be equal to KW, where:

[(1) K = 24 for vertical surfaces

[(2) K = 12 for horizontal surfaces; and

[(3) W = weight of the movable surfaces.]

(Change 523-5)

523.395 *Control System Loads*

(a) Each flight control system and its supporting structure must be designed for loads corresponding to at least 125 percent of the computed hinge moments of the movable control surface in the conditions prescribed in 523.391 through 523.459. In addition, the following apply:

(1) The system limit loads need not exceed the higher of the loads that can be produced by the pilot and automatic devices operating the controls. However, autopilot forces need not be added to pilot forces. The system must be designed for the maximum effort of the pilot or autopilot, whichever is higher. In addition, if the pilot and the autopilot act in opposition, the part of the system between them may be designed for the maximum effort of the one that imposes the lesser load. Pilot forces used for design need not exceed the maximum forces prescribed in 523.397(b).

(2) The design must, in any case, provide a rugged system for service use, considering jamming, ground gusts, taxiing downwind, control inertia, and friction. Compliance with this subparagraph may be shown by designing for loads resulting from application of the minimum forces prescribed in 523.397 (b).

(b) A 125 percent factor on computed hinge moments must be used to design elevator, aileron, and rudder systems. However, a factor as low as 1.0 may be used if hinge moments are based on accurate flight test data, the exact reduction depending upon the accuracy and reliability of the data.

(c) Pilot forces used for design are assumed to act at the appropriate control grips or pads as they would in flight, and to react at the attachments of the control system to the control surface horns.

523.397 *Limit Control Forces and Torques*

(a) In the control surface flight loading condition, the air loads on movable surfaces and the corresponding deflections need not exceed those that would result in flight from the application of any pilot force within the ranges specified in paragraph (b) of this section. In applying this criterion, the effects of control system boost and servo-mechanisms, and the effects of tabs must be considered. The automatic pilot effort must be used for design if it alone can produce higher control surface loads than the human pilot.

(b) The limit pilot forces and torques are as in Table below.

Control	*Maximum Forces Or Torques For Design Weight, Weight Equal To Or Less Than 5,000 Pounds*[1]	*Minimum Forces Or Torques*[2]
Aileron:		
Stick	67 lbs	40 lbs.
Wheel[3]	50 d in.-lbs.[4]	40 d in.-lbs.[4]
Elevator:		
Stick	167 lbs	100 lbs.
Wheel (symmetrical)	200 lbs	100 lbs.
Wheel (unsymmetrical)[5]		100 lbs.
Rudder	200 lbs	150 lbs.

[1]-For design weight (W) more than 5,000 pounds, the specified maximum values must be increased linearly with weight to 1.18 times the specified values at a design mass weight of 5700 kg (12566 lbs.) and for commuter category aeroplanes, the specified values must be increased linearly with weight to 1.35 times the specified values at a design weight of 19,000 pounds.

[2]-If the design of any individual set of control systems or surfaces makes these specified minimum forces or torques inapplicable, values corresponding to the present hinge moments obtained under sec. 523.415, but not less than 0.6 of the specified minimum forces or torques, may be used.

[3]-The critical parts of the aileron control system must also be designed for a single tangential force with a limit value of 1.25 times the couple force determined from the above criteria.

[4]-D = wheel diameter (inches).

[5]-The unsymmetrical force must be applied at one of the normal hand-grip points on the control wheel.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))

523.399 *Dual Control System*

(a) [Each dual control system must be designed to withstand the force of the pilots operating in opposition, using individual pilot forces not less than the greater of:

[(1) 0.75 times those obtained under 523.395; or

[(2) The minimum forces specified in 523.397(b).

(b) [Each dual control system must be designed to withstand the force of the pilots applied together, in the same direction, using individual pilot forces not less than 0.75 times those obtained under 523.395.]

(Change 523-5)

523.405 *Secondary Control System*

Secondary controls, such as wheel brakes, spoilers, and tab controls, must be designed for the maximum forces that a pilot is likely to apply to those controls.

523.407 *Trim Tab Effects*

The effects of trim tabs on the control surface design conditions must be accounted for only where the surface loads are limited by maximum pilot effort. In these cases, the tabs are considered to be deflected in the direction that would assist the pilot. These deflections must correspond to the maximum degree of "out of trim" expected at the speed for the condition under consideration.

523.409 *Tabs*

Control surface tabs must be designed for the most severe combination of airspeed and tab deflection likely to be obtained within the flight envelope for any usable loading condition.

523.415 *Ground Gust Conditions*

(a) The control system must be investigated as follows for control surface loads due to ground gusts and taxiing downwind:

(1) If an investigation of the control system for ground gust loads is not required by subparagraph (2) of this paragraph, but the applicant elects to design a part of the control system for these loads, these loads need only be carried from control surface horns through the nearest stops or gust locks and their supporting structures.

(2) [If pilot forces less than the minimums specified in 523.397(b) are used for design, the effects of surface loads due to ground gusts and taxiing downwind must be investigated for the entire control system according to the formula:

$$H=KcSq$$

[where:

H = limit hinge moment (ft.-lbs.);

c = mean chord of the control surface aft of the hinge line (ft.);

S = area of control surface aft of the hinge line (sq. ft.);

q = dynamic pressure (p.s.f.) based on a design speed not less than 14.6 $\sqrt{(W/S)}$ + 14.6 (f.p.s.) where W/S = wing loading at design maximum weight, except that the design speed need not exceed 88 (f.p.s.);

K = limit hinge moment factor for ground gusts derived in paragraph (b) of this section. (For ailerons and elevators, a positive value of K indicates a moment tending to depress the surface and a negative value of K indicates a moment tending to raise the surface).]

(b) The limit hinge moment factor K for ground gusts must be derived as in Table below.

Surface	*K*	*Position Of Controls*
(a) Aileron	0.75	(a) Control column locked or lashed in mid-position.
(b) Aileron	+0.50	(b) Ailerons at full throw; + moment on one aileron, moment on the other.
(c) Elevator	+0.75	(c) Elevator full up (-).
(d) Elevator	+0.75	(d) Elevator full down (+)
(e) Rudder	+0.75	(e) Rudder in neutral
(f) Rudder	+0.75	(f) Rudder at full throw.

(c) [At all weights between the empty weight and the maximum weight declared for tie-down stated in the appropriate manual, any declared tie-down points and surrounding structure, control system, surfaces and associated gust locks, must be designed to withstand the limit load conditions that exist when the aeroplane is tied down and that result from wind speeds of up to 65 knots horizontally from any direction.]

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

Horizontal Stabilizing and Balancing Surface

523.421 *Balancing Loads*

(a) A horizontal surface balancing load is a load necessary to maintain equilibrium in any specified flight condition with no pitching acceleration.

(b) Horizontal balancing surfaces must be designed for the balancing loads occurring at any point on the limit manoeuvring envelope and in the flap conditions specified in 523.345.

(Change 523-3 (92-01-02))

523.423 *Manoeuvring Loads*

Each horizontal surface and its supporting structure, and the main wing of a canard or tandem wing configuration, must be designed for manoeuvring loads imposed by the following conditions:

(a) A sudden movement of the pitching control, at V_A, to the maximum aft movement, and the maximum forward movement, as limited by the control stops, or pilot effort, whichever is critical.

(b) A sudden aft movement of the pitching control, at speeds above V_A, followed by a forward movement of the pitching control resulting in the following combinations of the normal and angular acceleration (see Table below).

Condition	*Normal Acceleration (n)*	*Angular Acceleration (radian / sec.²)*
Nose-up pitching	1.0	$+\frac{39}{V} n_m (n_m - 1.5)$
Nose-down pitching	Nm	$-\frac{39}{V} n_m (n_m - 1.5)$

Where:

(1) n_m = positive limit manoeuvring load factor used in the design of the aeroplane; and

(2) V = initial speed in knots.

The conditions in this paragraph involve loads corresponding to the loads that may occur in a "checked manoeuvre" (a manoeuvre in which the pitching control is suddenly displaced in one direction and then suddenly moved in the opposite direction). The deflections and timing of the "checked manoeuvre" must avoid exceeding the limit manoeuvring load factor. The total horizontal surface load for both nose-up and nose-down pitching conditions is the sum of the balancing loads at V and the specified value of the normal load factor n, plus the manoeuvring load increment due to the specified value of the angular acceleration.

(Change 523-1 (92-01-02))

523.425 *Gust Loads*

(a) Each horizontal surface other than a main wing must be designed for loads resulting from:

(1) Gust velocities specified in 523.333 (c) with flaps retracted; and

(2) Positive and negative gusts of 25 f.p.s. nominal intensity at V_F corresponding to the flight conditions specified in 523.345 (a)(2).

(b) (Reserved)

(c) When determining the total load on the horizontal surfaces for the conditions specified in paragraph (a) of this section, the initial balancing loads for steady unaccelerated flight at the pertinent design speeds V_F, V_C and V_D must first be determined. The incremental load resulting from the gusts must be added to the initial balancing load to obtain the total load.

(d) In the absence of a more rational analysis, the incremental load due to the gust must be computed as follows only on aeroplane configurations with aft-mounted, horizontal surfaces, unless its use elsewhere is shown to be conservative:

$$\Delta L_{ht} = \frac{K_g U_{de} V a_{ht} S_{ht}}{498}\left(1 - \frac{d\varepsilon}{d\alpha}\right)$$

where:

ΔL_{ht} = Incremental horizontal tail load (lbs.);

K_g = Gust alleviation factor defined in section 523.341;

U_{de} = Derived gust velocity (f.p.s.)

V = Aeroplane equivalent speed (knots);

a_{ht} = Slope of aft horizontal tail lift curve (per radian);

S_{ht} = Area of horizontal lift surface (ft.^{2}); and

$\left(1 - \frac{d\varepsilon}{d\alpha}\right)$ = Downwash factor.

(Change 523-3 (92-01-02))

523.427 *Unsymmetrical Loads*

(a) Horizontal surfaces other than main wing and their supporting structure must be designed for unsymmetrical loads arising from yawing and slipstream effects, in combination with the loads prescribed for the flight conditions set forth in 523.421 through 523.425.

(b) In the absence of more rational data for aeroplanes that are conventional in regard to location of engines, wings, horizontal surfaces other than main wing, and fuselage shape:

(1) 100 percent of the maximum loading from the symmetrical flight conditions may be assumed on the surface on one side of the plane of symmetry; and

(2) The following percentage of that loading must be applied to the opposite side % = 100-10 (n-1), where n is the specified positive manoeuvring load factor, but this value may not be more than 80 percent.

(c) For aeroplanes that are not conventional (such as aeroplanes with horizontal surfaces other than main wing having appreciable dihedral or supported by the vertical tail surfaces) the surfaces and supporting structures must be designed for combined vertical and horizontal surface loads resulting from each prescribed flight condition taken separately.

(Change 523-3 (92-01-02))

Vertical Surfaces

523.441 *Manoeuvring Loads*

(a) At speeds up to V_A, the vertical surfaces must be designed to withstand the following conditions. In computing the loads, the yawing velocity may be assumed to be zero:

(1) With the aeroplane in unaccelerated flight at zero yaw, it is assumed that the rudder control is suddenly displaced to the maximum deflection, as limited by the control stops or by limit pilot forces.

(2) [With the rudder deflected as specified in paragraph (a)(1) of this section, it is assumed that the aeroplane yaws to the overswing sideslip angle. In lieu of a rational analysis, an overswing angle equal to 1.5 times the static sideslip angle of paragraph (a)(3) of this section may be assumed.]

(3) A yaw angle of 15 degrees with the rudder control maintained in the neutral position (except as limited by pilot strength).

(b) [For commuter category aeroplanes, the loads imposed by the following additional manoeuvre must be substantiated at speeds from V_A to V_D/M_D. When computing the tail loads:

[(1) The aeroplane must be yawed to the largest attainable steady state sideslip angle, with the rudder at maximum deflection caused by any one of the following:

[(i) Control surface stops;

[(ii) Maximum available booster effort;

[(iii) Maximum pilot rudder force as shown below:

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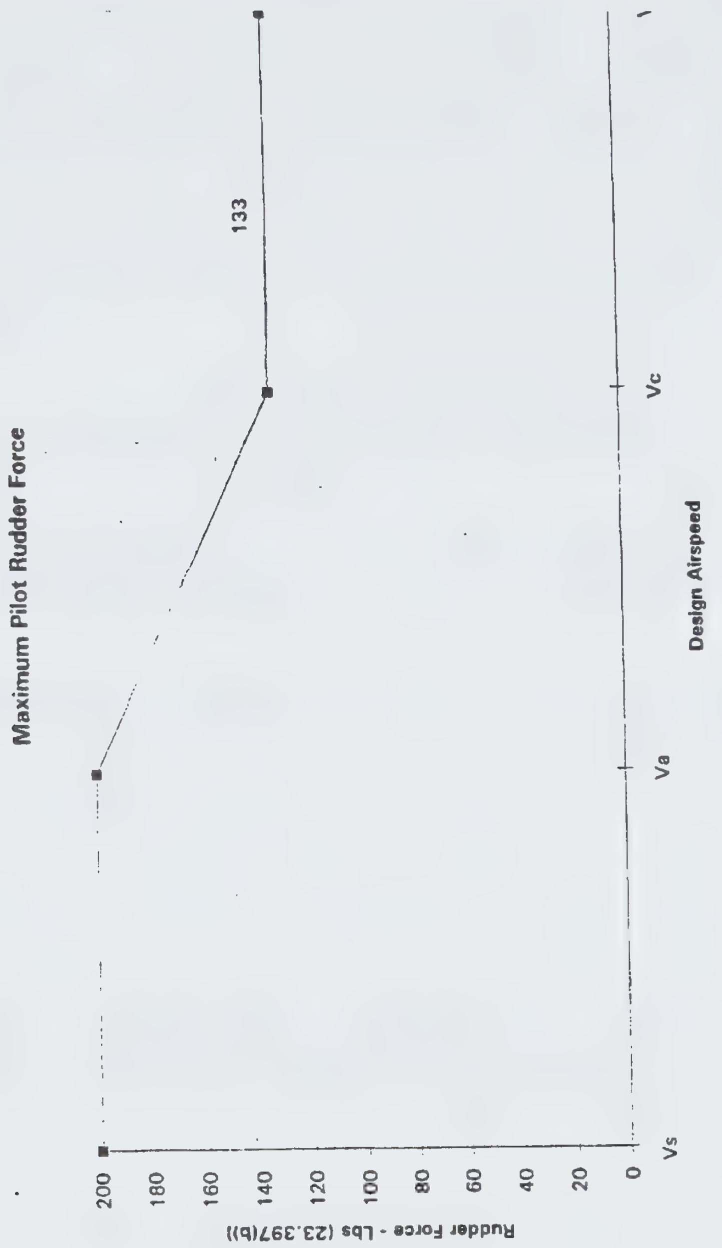


[(2) The rudder must be suddenly displaced from the maximum deflection to the neutral position.]

(c) The yaw angles specified in paragraph (a)(3) of this section may be reduced if the yaw angle chosen for a particular speed cannot be exceeded in:

(1) Steady slip conditions;

(2) Uncoordinated rolls from steep banks; or

(3) Sudden failure of the critical engine with delayed corrective action.

(Change 523-3 (92-01-02))
(Change 523-5)

523.443 *Gust Loads*

(a) Vertical surfaces must be designed to withstand, in un-accelerated flight at speed V_C, lateral gusts of the values prescribed for V_C in 523.333(c).

(b) In addition, for commuter category aeroplanes, the aeroplane is assumed to encounter derived gusts normal to the plane of symmetry while in un-accelerated flight at V_B, V_C, V_D, and V_F. The derived gusts and aeroplane speeds corresponding to these conditions, as determined by 523.341 and 523.345, must be investigated. The shape of the gust must be as specified in 523.333(c)(2)(i).

(c) [In the absence of a more rational analysis, the gust load must be computed as follows:

$$L_{vt}=\frac{K_{gt}U_{de}Va_{vt}S_{vt}}{498}$$

[Where:

L_{vt}= Vertical surface loads (lbs.);

$K_{gt}=\frac{0.88\mu_{gt}}{5.3+\mu_{gt}}$= gust alleviation factor;

$\mu_{gt}=\frac{2W}{\rho\bar{c}_t g a_{vt} S_{vt}}\frac{K^2}{1_{vt}}$ = lateral mass ratio

U_{de} = Derived gust velocity (f.p.s.);

ρ = Air density (slugs/cu. ft.);

W = The applicable weight of the aeroplane in the particular load case (lbs.);

S_{vt} = Area of vertical surface (ft.^{2});

$\bar{c}_t$ = Mean geometric chord of vertical surface (ft.);

a_{vt} = Lift curve slope of vertical surface (per radian);

K = Radius of gyration in yaw (ft.);

1_{vt} = Distance from aeroplane c.g. to lift centre of vertical surface (ft.);

g = Acceleration due to gravity (ft./sec.^{2}); and

V = Equivalent airspeed (knots).]

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))
(Change 523-5)

523.445 *Outboard Fins or Winglets*

(a) If outboard fins or winglets are included on the horizontal surfaces or wings, the horizontal surfaces or wings must be designed for their maximum load in combination with loads induced by the fins or winglets and moments or forces exerted on the horizontal surfaces or wings by the fins or winglets.

(b) If outboard fins or winglets extend above and below the horizontal surface, the critical vertical surface loading (the load per unit area as determined under 523.441 and 523.443) must be applied to:

(1) The part of the vertical surfaces above the horizontal surface with 80 percent of that loading applied to the part below the horizontal surface; and

(2) The part of the vertical surfaces below the horizontal surface with 80 percent of that loading applied to the part above the horizontal surface.

(c) The end plate effects of outboard fins or winglets must be taken into account in applying the yawing conditions of 523.441 and 523.443 to the vertical surfaces in paragraph (b) of this section.

(d) When rational methods are used for computing loads, the manoeuvring loads of 523.441 on the vertical surfaces and the one-g horizontal surface load, including induced loads on the horizontal surface and moments or forces exerted on the horizontal surfaces by the vertical surfaces, must be applied simultaneously for the structural loading condition.

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))

[Ailerons and Special Devices]

523.455 *Ailerons*

(a) The ailerons must be designed for the loads to which they are subjected:

(1) In the neutral position during symmetrical flight conditions; and

(2) By the following deflections (except as limited by pilot effort), during unsymmetrical flight conditions; and

(i) Sudden maximum displacement of the aileron control at V_A. Suitable allowance may be made for control system deflections.

(ii) Sufficient deflection at V_C, where V_C is more than V_A, to produce a rate of roll not less than obtained in subparagraph (2)(i).

(iii) Sufficient deflection at V_A to produce a rate of roll not less than one-third of that obtained in subparagraph (2)(i).

(b) (Reserved)

(Change 523-3 (92-01-02))
(Change 523-5)

523.457 *Wing Flaps [Removed]*

(Change 523-5)

523.459 *Special Devices*

The loading for special devices using aerodynamic surfaces (such as slots and spoilers) must be determined from test data.

Ground Loads

523.471 *General*

The limit ground loads specified in this subchapter are considered to be external loads and inertia forces that act upon an aeroplane structure. In each specified ground load condition, the external reactions must be placed in equilibrium with the linear and angular inertia forces in a rational or conservative manner.

523.473 *Ground Load Conditions and Assumptions*

(a) The ground load requirements of this subchapter must be complied with at the design maximum weight except that 523.479, 523.481, and 523.483 may be complied with at a design landing weight (the highest weight for landing conditions at the maximum descent velocity) allowed under paragraphs (b) and (c) of this section.

(b) The design landing weight may be as low as:

(1) 95 percent of the maximum weight if the minimum fuel capacity is enough for at least one-half hour of operation at maximum continuous power plus a capacity equal to a fuel weight which is the difference between the design maximum weight and the design landing weight; or

(2) The design maximum weight less the weight of 25 percent of the total fuel capacity.

(c) The design landing weight of a multi-engine aeroplane may be less than that allowed under paragraph (b) of this section if:

(1) [The aeroplane meets the one-engine-inoperative climb requirements of 523.67(b)(1) or (c); and]

(2) Compliance is shown with the fuel jettisoning system requirements of 523.1001.

(d) The selected limit vertical inertia load factor at the centre of gravity of the aeroplane for the ground load conditions prescribed in this subchapter may not be less than that which would be obtained when landing with a descent velocity (V), in feet per second, equal to 4.4 (W/S)1/4, except that this velocity need not be more than 10 feet per second and may not be less than seven feet per second.

(e) Wing lift not exceeding two-thirds of the weight of the aeroplane may be assumed to exist throughout the landing impact and to act through the centre of gravity. The ground reaction load factor may be equal to the inertia load factor minus the ratio of the above assumed wing lift to the aeroplane weight.

(f) [If energy absorption tests are made to determine the limit load factor corresponding to the required limit descent velocities, these tests must be made under 523.723(a)]

(g) No inertia load factor used for design purposes may be less than 2.67, nor may the limit ground reaction load factor be less than 2.0 at design maximum weight, unless these lower values will not be exceeded in taxiing at speeds up to takeoff speed over terrain as rough as that expected in service.

(Change 523-4 (96-09-01))
(Change 523-5)

523.477 *Landing Gear Arrangement*

Sections 523.479 through 523.483, or the conditions in Appendix C, apply to aeroplanes with conventional arrangements of main and nose gear, or main and tail gear.

523.479 *Level Landing Conditions*

(a) For a level landing, the aeroplane is assumed to be in the following attitudes:

(1) For aeroplanes with tail wheels, a normal level flight attitude.

(2) For aeroplanes with nose wheels, attitudes in which:

(i) The nose and main wheels contact the ground simultaneously; and

(ii) The main wheels contact the ground and the nose wheel is just clear of the ground.

The attitude used in subdivision (i) of this subparagraph may be used in the analysis required under subdivision (ii) of this subparagraph.

(b) When investigating landing conditions, the drag components simulating the forces required to accelerate the tires and wheels up to the landing speed (spin-up) must be properly combined with the corresponding instantaneous vertical ground reactions, and the forward-acting horizontal loads resulting from rapid reduction of the spin-up drag loads (spring-back) must be combined with vertical ground reactions at the instant of the peak forward load, assuming wing lift and a tire-sliding coefficient of friction of 0.8. However, the drag loads may not be less than 25 percent of the maximum vertical ground reactions (neglecting wing lift).

(c) In the absence of specific tests or a more rational analysis for determining the wheel spin-up and spring-back loads for landing conditions, the method set forth in Appendix D of this chapter must be used. If Appendix D of this chapter is used, the drag components used for design must not be less than those given by Appendix C of this chapter.

(d) For aeroplanes with tip tanks or large overhung masses (such as turbo-propeller or jet engines) supported by the wing, the tip tanks and the structure supporting the tanks or overhung masses must be designed for the effects of dynamic responses under the level landing conditions of either paragraph (a)(1) or (a)(2)(ii) of this section. In evaluating the effects of dynamic response, an aeroplane lift equal to the weight of the aeroplane may be assumed.

(Change 523-4 (96-09-01))

523.481 *Tail Down Landing Conditions*

(a) For a tail down landing, the aeroplane is assumed to be in the following attitudes:

(1) For aeroplanes with tail wheels, an attitude in which the main and tail wheels contact the ground simultaneously.

(2) For aeroplanes with nose wheels, a stalling attitude, or the maximum angle allowing ground clearance by each part of the aeroplane, whichever is less.

(b) For aeroplanes with either tail or nose wheels, ground reactions are assumed to be vertical, with the wheels up to speed before the maximum vertical load is attained.

523.483 *One-wheel Landing Conditions*

For the one-wheel landing condition, the aeroplane is assumed to be in the level attitude and to contact the ground on one side of the main landing gear. In this attitude, the ground reactions must be the same as those obtained on that side under 523.479.

523.485 *Side Load Conditions*

(a) For the side load condition, the aeroplane is assumed to be in a level attitude with only the main wheels contacting the ground and with the shock absorbers and tires in their static positions.

(b) The limit vertical load factor must be 1.33, with the vertical ground reaction divided equally between the main wheels.

(c) The limit side inertia factor must be 0.83, with the side ground reaction divided between the main wheels so that:

(1) 0.5 (W) is acting inboard on one side; and

(2) 0.33 (W) is acting outboard on the other side.

(d) The side loads prescribed in paragraph (c) of this section are assumed to be applied at the ground contact point and the drag loads may be assumed to be zero.

(Change 523-4 (96-09-01))

523.493 *Braked Roll Conditions*

Under braked roll conditions, with the shock absorbers and tires in their static positions, the following apply:

(a) The limit vertical load factor must be 1.33.

(b) The attitudes and ground contacts must be those described in 523.479 for level landings.

(c) A drag reaction equal to the vertical reaction at the wheel multiplied by a coefficient of friction of 0.8 must be applied at the ground contact point of each wheel with brakes, except that the drag reaction need not exceed the maximum value based on limiting brake torque.

523.497 *Supplementary Conditions for Tail Wheels*

In determining the ground loads on the tail wheel and affected supporting structures, the following apply:

(a) For the obstruction load, the limit ground reaction obtained in the tail down landing condition is assumed to act up aft through the axle at 45 degrees. The shock absorber and tire may be assumed to be in their static positions.

(b) For the side load, a limit vertical ground reaction equal to the static load on the tail wheel, in combination with a side component of equal magnitude, is assumed. In addition:

(1) If a swivel is used, the tail wheel is assumed to be swivelled 90° to the aeroplane longitudinal axis with the resultant ground load passing through the axle;

(2) If a lock steering device, or shimmy damper is used, the tail wheel is also assumed to be in the trailing position with the side load acting at the ground contact point; and

(3) The shock absorber and tire are assumed to be in their static positions.

[(c) If a tail wheel, bumper, or an energy absorption device is provided to show compliance with 523.925(b), the following apply:

[(1) Suitable design loads must be established for the tail wheel, bumper, or energy absorption device; and

[(2) The supporting structure of the tail wheel, bumper, or energy absorption device must be designed to withstand the loads established in paragraph (c)(1) of this section.]

(Change 523-5)

523.499 *Supplementary Conditions for Nose Wheels*

In determining the ground loads on nose wheels and affected supporting structures, and assuming that the shock absorbers and tires are in their static positions, the following conditions must be met:

(a) For aft loads, the limit force components at the axle must be:

(1) A vertical component of 2.25 times the static load on the wheel; and

(2) A drag component of 0.8 times the vertical load.

(b) For forward loads, the limit force components at the axle must be:

(1) A vertical component of 2.25 times the static load on the wheel; and

(2) A forward component of 0.4 times the vertical load.

(c) For side loads, the limit force components at ground contact must be:

(1) A vertical component of 2.25 times the static load on the wheel; and

(2) A side component of 0.7 times the vertical load.

[(d) For aeroplanes with a steerable nose wheel that is controlled by hydraulic or other power, at design takeoff weight with the nose wheel in any steerable position, the application of 1.33 times the full steering torque combined with a vertical reaction equal to 1.33 times the maximum static reaction on the nose gear must be assumed. However, if a torque limiting device is installed, the steering torque can be reduced to the maximum value allowed by that device.

[(e) For aeroplanes with a steerable nose wheel that has a direct mechanical connection to the rudder pedals, the mechanism must be designed to withstand the steering torque for the maximum pilot forces specified in 523.397(b).]

(Change 523-5)

523.505 *Supplementary Conditions for Skiplanes*

In determining ground loads for skiplanes and assuming that the aeroplane is resting on the ground with one main ski frozen at rest and the other skis free to slide, a limit side force equal to 0.036 times the design maximum weight must be applied near the tail assembly, with a factor of safety of 1.

523.507 *Jacking Loads*

(a) The aeroplane must be designed for the loads developed when the aircraft is supported on jacks at the design maximum weight assuming he following load factors for landing gear jacking points at a three point attitude and for primary flight structure jacking points in the level attitude:

(1) Vertical-load factor of 1.35 times the static reactions.

(2) Fore, aft, and lateral load factors of 0.4 times the vertical static reactions.

(b) The horizontal loads at the jack points must be reacted by inertia forces so as to result in no change in the direction of the resultant loads at the jack points.

(c) The horizontal loads must be considered in all combinations with the vertical load.

523.509 *Towing Loads*

The towing loads of this section must be applied to the design of tow fittings and their immediate attaching structure.

(a) The towing loads specified in paragraph (d) of this section must be considered separately. These loads must be applied at the towing fittings and must act parallel to the ground. In addition:

(1) A vertical load factor equal to 1.0 must be considered acting at the centre of gravity; and

(2) The shock struts and tires must be in their static positions.

(b) For towing points not on the landing gear but near the plane of symmetry of the aeroplane, the drag and side tow load components specified for the auxiliary gear apply. For towing points located outboard of the main gear, the drag and side tow load components specified for the main gear apply. Where the specified angle of swivel cannot be reached, the maximum obtainable angle must be used.

(c) The towing loads specified in paragraph (d) of this section must be reacted as follows:

(1) The side component of the towing load at the main gear must be reacted by a side force at the static ground line of the wheel to which the load is applied.

(2) The towing loads at the auxiliary gear and the drag components of the towing loads at the main gear must be reacted as follows:

(i) A reaction with a maximum value equal to the vertical reaction must be applied at the axle of the wheel to which the load is applied. Enough aeroplane inertia to achieve equilibrium must be applied.

(ii) The loads must be reacted by aeroplane inertia.

(d) The prescribed towing loads are as per Table below, where W is the design maximum weight:

Tow Point	*Position*	*Load*		
		Magnitude	*No.*	*Direction*
Main gear		0.225 W per main gear unit	1	Forward, parallel to drag axis.
			2	Forward, at 30° to drag axis.
			3	Aft, parallel to drag axis.
			4	Aft, at 30° to drag axis.
Auxiliary gear	Swivelled forward	0.3 W	5	Forward
			6	Aft
	Swivelled aft		7	Forward
			8	Aft
	Swivelled 45°from forward	0.15W	9	Forward, in plane of wheel
			10	Aft, in plane of wheel
	Swivelled 45° from aft	0.15W	11	Forward, in plane of wheel
			12	Aft, in plane of wheel

523.511 *Ground Load; Unsymmetrical Loads on Multiple-Wheel Units*

(a) *Pivoting loads.* The aeroplane is assumed to pivot about on side of the main gear with:

(1) The brakes on the pivoting unit locked; and

(2) Loads corresponding to a limit vertical load factor of 1, and coefficient of friction of 0.8 applied to the main gear and its supporting structure.

(b) *Unequal tire loads.* The loads established under 523.471 through 523.483 must be applied in turn, in a 60/40 percent distribution, to the dual wheels and tires in each dual wheel landing gear unit.

(c) *Deflated tire loads.* For the deflated tire condition:

(1) 60 percent of the loads established under 523.471 through 523.483 must be applied in turn to each wheel in a landing gear unit; and

(2) 60 percent of the limit drag and side loads, and 100 percent of the limit vertical load established under 523.485 and 523.493 or lesser vertical load obtained under subparagraph (1) of this paragraph, must be applied in turn to each wheel in the dual wheel landing gear unit.

Water Loads

523.521 *Water Load Conditions*

(a) The structure of seaplanes and amphibians must be designed for water loads developed during takeoff and landing with the seaplane in any attitude likely to occur in normal operation at appropriate forward and sinking velocities under the most severe sea conditions likely to be encountered.

(b) Unless the applicant makes a rational analysis of the water loads, 523.523 through 523.537 apply.

(c) [Removed]

(Change 523-4 (96-09-01))
(Change 523-5)

523.523 *Design Weights and Centre of Gravity Positions*

(a) *Design weights.* The water load requirements must be met at each operating weight up to the design landing weight except that, for the takeoff condition prescribed in 523.531, the design water takeoff weight (the maximum weight for water taxi and takeoff run) must be used.

(b) *Centre of gravity positions.* The critical centres of gravity within the limits for which certification is requested must be considered to reach maximum design loads for each part of the seaplane structure.

(Change 523-4 (96-09-01))

523.525 *Application of Loads*

(a) Unless otherwise prescribed, the seaplane as a whole is assumed to be subjected to the loads corresponding to the load factors specified in 523.527.

(b) In applying the loads resulting from the load factors prescribed in 523.527, the loads may be distributed over the hull or main float bottom (in order to avoid excessive local shear loads and bending moments at the location of water load application) using pressures not less than those prescribed in 523.533(b).

(c) For twin float seaplanes, each float must be treated as an equivalent hull on a fictitious seaplane with a weight equal to one-half the weight of the twin float seaplane.

(d) Except in the takeoff condition of 523.531, the aerodynamic lift on the seaplane during the impact is assumed to be 2/3 of the weight of the seaplane.

(Change 523-4 (96-09-01))

523.527 *Hull and Main Float Load Factors*

(a) Water reaction load factors n_w must be computed in the following manner:

(1) For the step landing case

$$n_w = \frac{C_1 V_{SO}{}^2}{(\mathrm{Tan}^{2/3}\beta) W^{1/3}}$$

(2) For the bow and stern landing cases

$$n_w = \frac{C_1 V_{SO}{}^2}{(\mathrm{Tan}^{2/3}\beta) W^{1/3}} \times \frac{K_1}{(1 + r_x{}^2)^{2/3}}$$

(b) The following values are used:

(1) n_w = water reaction load factor (that is, the water reaction divided by seaplane weight).

(2) C_1 = empirical seaplane operations factor equal to 0.012 (except that this factor may not be less than that necessary to obtain the minimum value of step load factor of 2.33).

(3) V_{SO} = seaplane stalling speed in knots with flaps extended in the appropriate landing position and with no slipstream effect.

(4) β = Angle of dead rise at the longitudinal station at which the load factor is being determined in accordance with figure I-i of Appendix I of this chapter.

(5) W = seaplane design landing weight in pounds.

(6) K_1 = empirical hull station weighing factor, in accordance with figure I-ii of Appendix I of this chapter.

(7) r_x = ratio of distance, measured parallel to hull reference axis, from the centre of gravity of the seaplane to the hull longitudinal station at which the load factor is being computed to the radius of gyration in pitch of the seaplane, the hull reference axis being a straight line, in the plane of symmetry, tangential to the keel at the main step.

(c) For a twin float seaplane, because of the effect of flexibility of the attachment of the floats to the seaplane, the factor K_1 may be reduced at the bow and stern to 0.8 of the value shown in figure I-ii of Appendix I of this chapter. This reduction applies only to the design of the carry-through and seaplane structure.

(Change 523-4 (96-09-01))

523.529 *Hull and Main Float Landing Conditions*

(a) *Symmetrical step, bow, and stern landing.* For symmetrical step, bow, and stern landings, the limit water reaction load factors are those computed under 523.527. In addition:

(1) For symmetrical step landings, the resultant water load must be applied at the keel, through the centre of gravity, and must be directed perpendicularly to the keel line;

(2) For symmetrical bow landings, the resultant water load must be applied at the keel, one-fifth of the longitudinal distance from the bow to the step, and must be directed perpendicularly to the keel line; and

(3) For symmetrical stern landings, the resultant water load must be applied at the keel, at a point 85 percent of the longitudinal distance from the step to the stern post, and must be directed perpendicularly to the keel line.

(b) *Unsymmetrical landing for hull and single float seaplanes.* Unsymmetrical step, bow, and stern landing conditions must be investigated. In addition:

(1) The loading for each condition consists of an upward component and a side component equal, respectively, to 0.75 and 0.25 tan β times the resultant load in the corresponding symmetrical landing condition; and

(2) The point of application and direction of the upward component of the load is the same as that in the symmetrical condition, and the point of application of the side component is at the same longitudinal station as the upward component but is directed inward perpendicularly to the plane of symmetry at a point midway between the keel and chine lines.

(c) *Unsymmetrical landing; twin float seaplanes.* The unsymmetrical loading consists of an upward load at the step of each float of 0.75 and a side load of 0.25 tan β at one float times the step landing load reached under 523.527. The side load is directed inboard, perpendicularly to the plane of symmetry midway between the keel and chine lines of the float, at the same longitudinal station as the upward load.

(Change 523-4 (96-09-01))

523.531 *Hull and Main Float Takeoff Condition*

For the wing and its attachment to the hull or main float:

(a) The aerodynamic wing lift is assumed to be zero; and

(b) A downward inertia load, corresponding to a load factor computed from the following formula, must be applied:

$$n = \frac{C_{TO} V_{S1}^{\ 2}}{\left(Tan^{2/3}\beta\right)W^{1/3}}$$

where:

n = inertia load factor;

C_{TO} = empirical seaplane operations factor equal to 0.004;

V_{S1} = seaplane stalling speed (knots) at the design takeoff weight with the flaps extended in the appropriate takeoff position;

β = angle of dead rise at the main step (degrees); and

W = design water takeoff weight in pounds.

(Change 523-4 (96-09-01))

523.533 *Hull and Main Float Bottom Pressures*

(a) *General.* The hull and main float structure, including frames and bulkheads, stringers, and bottom plating, must be designed under this section.

(b) *Local pressures.* For the design of the bottom plating and stringers and their attachments to the supporting structure, the following pressure distributions must be applied:

(1) For an unflared bottom, the pressure at the chine is 0.75 times the pressure at the keel, and the pressures between the keel and chine vary linearly, in accordance with figure I-iii of Appendix I of this chapter. The pressure at the keel (p.s.i.) is computed as follows:

$$P_K = \frac{C_2 K_2 V_{S1}^{\ 2}}{Tan\beta_K}$$

where:

P_k = pressure (p.s.i.) at the keel;

C_2 = 0.00213;

K_2 = hull station weighing factor, in accordance with figure I-ii of Appendix I of this chapter;

V_{S1} = seaplane stalling speed (knots) at the design water takeoff weight with flaps extended in the appropriate takeoff position; and

β_K = angle of dead rise at keel, in accordance with figure I-i of Appendix I of this chapter.

(2) For a flared bottom, the pressure at the beginning of the flare is the same as that for an unflared bottom, and the pressure between the chine and the beginning of the flare varies linearly, in accordance with figure I-iii of Appendix I of this chapter. The pressure distribution is the same as that prescribed in paragraph (b)(1) of this section for an unflared bottom except that the pressure at the chine is computed as follows:

$$P_{ch} = \frac{C_3 K_2 V_{S1}^{\,2}}{\text{Tan}\beta}$$

where:

P_{ch} = pressure (p.s.i.) at the chine;

C_3 = 0.0016;

K_2 = hull station weighing factor, in accordance with figure I-ii of Appendix I of this chapter;

V_{S1} = seaplane stalling speed (knots) at the design water takeoff weight with flaps extended in the appropriate takeoff position; and

β = angle of dead rise at appropriate station.

The area over which these pressures are applied must simulate pressures occurring during high localized impacts on the hull or float, but need not extend over an area that would induce critical stresses in the frames or in the overall structure.

(c) *Distributed pressures.* For the design of the frames, keel, and chine structure, the following pressure distributions apply:

(1) Symmetrical pressures are computed as follows:

$$P = \frac{C_4 K_2 V_{SO}^{\,2}}{\text{Tan}\beta}$$

where:

P = pressure (p.s.i.);

$C_4 = 0.078\ C_1$ (with C_1 computed under 523.527);

K_2 = hull station weighing factor, determined in accordance with figure I-ii of Appendix I of this chapter;

V_{SO} = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect; and

β = angle of dead rise at appropriate station.

(2) The unsymmetrical pressure distribution consists of the pressures prescribed in paragraph (c)(1) of this section on one side of the hull or main float centreline and one-half of that pressure on the other side of the hull or main float centreline, in accordance with figure I-iii of Appendix I of this chapter.

(3) These pressures are uniform and must be applied simultaneously over the entire hull or main float bottom. The loads obtained must be carried into the sidewall structure of the hull proper, but need not be transmitted in a fore and aft direction as shear and bending loads.

(Change 523-4 (96-09-01))

523.535 *Auxiliary Float Loads*

(a) *General.* Auxiliary floats and their attachments and supporting structures must be designed for the conditions prescribed in this section. In the cases specified in paragraphs (b) through (e) of this section, the prescribed water loads may be distributed over the float bottom to avoid excessive local loads, using bottom pressures not less than those prescribed in paragraph (g) of this section.

(b) *Step loading.* The resultant water load must be applied in the plane of symmetry of the float at a point three-fourths of the distance from the bow to the step and must be perpendicular to the keel. The resultant limit load is computed as follows, except that the value of L need not exceed three times the weight of the displaced water when the float is completely submerged:

$$L = \frac{C_5 V_{SO}^{\,2} W^{2/3}}{\operatorname{Tan}^{2/3}\beta_s \left(1 + r_y^{\,2}\right)^{2/3}}$$

where:

L = limit load (lbs.);

$C_5 = 0.0053$;

V_{SO} = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect;

W = seaplane design landing weight in pounds;

β_s = angle of dead rise at a station 3/4 of the distance from the bow to the step, but need not be less than 15 degrees; and

r_y = ratio of the lateral distance between the centre of gravity and the plane of symmetry of the float to the radius of gyration in roll.

(c) *Bow loading.* The resultant limit load must be applied in the plane of symmetry of the float at a point one-fourth of the distance from the bow to the step and must be perpendicular to the tangent to the keel line at that point. The magnitude of the resultant load is that specified in paragraph (b) of this section.

(d) *Unsymmetrical step loading.* The resultant water load consists of a component equal to 0.75 times the load specified in paragraph (a) of this section and a side component equal to 3.25 tan β times the load specified in paragraph (b) of this section. The side load must be applied perpendicularly to the plane of symmetry of the float at a point midway between the keel and the chine.

(e) *Unsymmetrical bow loading.* The resultant water load consists of a component equal to 0.75 times the load specified in paragraph (b) of this section and a side component equal to 0.25 tan β times the load specified in paragraph (c) of this section. The side load must be applied perpendicularly to the plane of symmetry at a point midway between the keel and the chine.

(f) *Immersed float condition.* The resultant load must be applied at the centroid of the cross section of the float at a point one-third of the distance from the bow to the step. The limit load components are as follows:

$$vertical = \rho g V$$

$$aft = \frac{C_x \rho V^{\frac{2}{3}} (K V_{so})^2}{2}$$

$$side = \frac{C_Y \rho V^{\frac{2}{3}} (K V_{so})^2}{2}$$

where:

ρ = mass density of water (slugs/ft.^{3})

V = volume of float(ft.^{3});

C_X = coefficient of drag force, equal to 0.133;

C_Y = coefficient of side force, equal to 0.106;

K = 0.8, except that lower values may be used if it is shown that the floats are incapable of submerging at a speed of 0.8 V_{SO} in normal operations;

V_{SO} = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect; and

g = acceleration due to gravity (ft/sec^2).

(g) *Float bottom pressures.* The float bottom pressures must be established under 523.533, except that the value of K_2 in the formulae may be taken as 1.0. The angle of dead rise to be used in determining the float bottom pressures is set forth in paragraph (b) of this section.

(Change 523-4 (96-09-01))

523.537 *Sea-wing Loads*

Sea-wing design loads must be based on applicable test data.

(Change 523-4 (96-09-01))

Emergency Landing Conditions

523.561 *General*

(a) The aeroplane, although it may be damaged in emergency landing conditions, must be designed as prescribed in this section to protect each occupant under those conditions.

(b) [The structure must be designed to give each occupant every reasonable chance of escaping serious injury when:]

(1) Proper use is made of seats, safety belts or harnesses provided for in the design;

(2) The occupant experiences the static inertia loads corresponding to the following ultimate load factors:

(i) Upward 3.0g for normal, utility, and commuter category aeroplane, or 4.5g for aerobatic category aeroplanes;

(ii) Forward, 9.0 g;

(iii) Sideward, 1.5g; and

[(iv) Downward, 6.0g when certification to the emergency exit provisions of 523.807(d)(4) is requested; and]

(3) The items of mass within the cabin, that could injure an occupant, experience the static inertia loads corresponding to the following ultimate load factors

(i) Upward, 3.0g;

(ii) Forward, 18.0 g; and

(iii) Sideward, 4.5g.

(c) Each aeroplane with retractable landing gear must be designed to protect each occupant in a landing:

(1) With the wheels retracted;

(2) With moderate descent velocity; and

(3) Assuming, in the absence of a more rational analysis:

(i) A downward ultimate inertia force of 3g; and

(ii) A coefficient of friction of 0.5 at the ground.

(d) If it is not established that a turnover is unlikely during an emergency landing, the structure must be designed to protect the occupants in a complete turnover as follows:

(1) The likelihood of a turnover may be shown by an analysis assuming the following conditions:

(i) [The most adverse combination of weight and centre of gravity position;

(ii) [Longitudinal load factor of 9.0g;

(iii) [Vertical load factor of 1.0g; and

(iv) [For aeroplanes with tricycle landing gear, the nose wheel strut failed with the nose contacting the ground.]

(2) For determining the loads to be applied to the inverted aeroplane after a turnover, an upward ultimate inertia load factor of 3.0g and a coefficient of friction with the ground of 0.5 must be used.

(e) [Except as provided in 523.787(c), the supporting structure must be designed to restrain, under loads up to those specified in paragraph (b)(3) of this section, each item of mass that could injure an occupant if it came loose in a minor crash landing.]

(Change 523-1 (88-01-01))
(Change 523-2 (89-01-01))
(Change 523-5)

523.562 *Emergency Landing Dynamic Conditions*

(a) Each seat/restraint system for use in a normal, utility, or aerobatic category aeroplane must be designed to protect each occupant during an emergency landing when:

(1) Proper used is made of seats, safety belts, and shoulder harnesses provided for in the design; and

(2) The occupant is exposed to the loads resulting from the conditions prescribed in this section.

(b) Except for those seat/restraint systems that are required to meet paragraph (d) of this section, each seat/restraint system, for crew or passenger occupancy in a normal, utility, or aerobatic category aeroplane, must successfully complete dynamic tests or be demonstrated by rational analysis supported by dynamic tests, in accordance with each of the following conditions. These tests must be conducted with an occupant simulated by an anthropomorphic test dummy (ATD) defined by Title 49 of the United States Code of Federal Regulations Part 572 Subpart B or an equivalent document approved by the Minister, with a nominal weight of 170 pounds and seated in the normal upright position.

(1) For the first test, the change in velocity may not be less than 31 feet per second. The seat/restraint system must be oriented in its nominal position with respect to the aeroplane and with the horizontal plane of the aeroplane pitched up 60 degrees, with no yaw, relative to the impact vector. For seat/restraint systems to be installed in the first row of the aeroplane, peak deceleration must occur in not more than 0.05 seconds after impact and must reach a minimum of 19g. For all other seat/restraint systems, peak deceleration must occur in not more than 0.06 seconds after impact and must reach a minimum of 15g.

(2) For the second test, the change in velocity may not be less than 42 feet per second. The seat/restraint system must be oriented in its nominal position with respect to the aeroplane and with the vertical plane of the aeroplane yawed 10 degrees, with no pitch, relative to the impact vector in a direction that results in the greatest load on the shoulder harness. For seat/restraint systems to be installed in the first row of the aeroplane, peak deceleration must occur in not more than 0.05 seconds after impact and must reach a minimum of 26g. For all other seat/restraint systems, peak deceleration must occur in not more than 0.06 seconds after impact and must reach a minimum of 21g.

(3) To account for floor warpage, the floor rails or attachment devices used to attach the seat/restraint system to the airframe structure must be preloaded to misalign with respect to each other by at least 10 degrees vertically (i.e., pitch out of parallel) and

one of the rails or attachment devices must be preloaded to misalign by 10 degrees in roll prior to conducting the test defined by paragraph (b)(2) of this section.

(c) Compliance with the following requirements must be shown during the dynamic tests conducted in accordance with paragraph (b) of this section:

(1) The seat/restraint system must restraint the ATD although seat/restraint system components may experience deformation, elongation, displacement, or crushing intended as part of the design.

(2) The attachment between the seat/restraint system and the test fixture must remain intact, although the seat structure may have deformed.

(3) Each shoulder harness strap must remain on the ATD's shoulder during the impact.

(4) The safety belt must remain on the ATD's pelvis during the impact.

(5) The results of the dynamic tests must show that the occupant is protected from serious head injury.

(i) When contact with adjacent seats, structure, or other items in the cabin can occur, protection must be provided so that the head impact does not exceed a head injury criteria (HIC) of 1,000.

(ii) The value of HIC is defined as:

$$HIC = \left\{ (t_2 - t_1) \left[\frac{1}{(t_2 - t_1)} \int_{t1}^{t2} a(t)\, dt \right]^{2.5} \right\}_{Max}$$

Where: t_1 is the initial integration time, expressed in seconds, t_2 is the final integration time, expressed in seconds, $(t_2 - t_1)$ is the time duration of the major head impact, expressed in seconds, and a(t) is the resultant deceleration at the centre of gravity of the head form expressed as a multiple of g (units of gravity).

(iii) Compliance with the HIC limit must be demonstrated by measuring the head impact during dynamic testing as prescribed in paragraphs (b)(1) and (b)(2) of this section or by a separate showing of compliance with the head injury criteria using test or analysis procedures.

(6) Loads in individual shoulder harness straps may not exceed 1,750 pounds. If dual straps are used for retaining the upper torso, the total strap loads may not exceed 2,000 pounds.

(7) The compression load measured between the pelvis and the lumbar spine of the ATD may not exceed 1,500 pounds.

(d) [For all single-engine aeroplanes with a V_{SO} of more than 61 knots at maximum weight, and those multi-engine aeroplanes of 6,000 pounds or less maximum weight with a V_{SO} of more than 61 knots at maximum weight that do not comply with 523.67(a)(1);]

(1) The ultimate load factors of 523.561(b) must be increased by multiplying the load factors by the square of the ratio of the increased stall speed to 61 knots. The increased ultimate load factors need not exceed the values reached at a V_{SO} of 79 knots. The upward ultimate load factor for aerobatic category aeroplanes need not exceed 5.0g.

(2) The seat/restraint system test required by paragraph (b)(1) of this section must be conducted in accordance with the following criteria:

(i) The change in velocity may not be less than 31 feet per second.

(ii)

(A) The peak deceleration (g_p) of 19g and 15g must be increased and multiplied by the square of the ratio of the increased stall speed to 61 knots:

$g_p = 19.0(V_{so}/61)^2$ or

$g_p = 15.0(V_{so}/61)^2$

(B) The peak deceleration need not exceed the value reached at a V_{SO} of 79 knots.

(iii) The peak deceleration must occur in not more than time (t_r), which must be computed as follows:

$$t_r = \frac{31}{32.2(g_p)} = \frac{.96}{g_p}$$

where:

g_p = The peak deceleration calculated in accordance with paragraph (d)(2)(ii) of this section

t_r = The rise time (in seconds) to the peak deceleration.

(e) An alternate approach that achieves an equivalent, or greater, level of occupant protection to that required by this section may be used if substantiated on a rational basis.

(Change 523-2 (89-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

Fatigue Evaluation

523.571 *[Metallic Pressurized Cabin Structures*

[For normal, utility, and aerobatic category aeroplanes, the strength, detail design, and fabrication of the metallic structure of the pressure cabin must be evaluated under one of the following:

(a) [A fatigue strength investigation in which the structure is shown by tests, or by analysis supported by test evidence, to be able to withstand the repeated loads of variable magnitude expected in service; or]

(b) A fail safe strength investigation, in which it is shown by analysis, tests, or both that catastrophic failure of the structure is not probable after fatigue failure, or obvious partial failure, of a principal structural element, and that the remaining structures are able to withstand a static ultimate load factor of 75 percent of the limit load factor at V_C, considering the combined effects of normal operating pressures, expected external aerodynamic pressures, and flight loads. These loads must be multiplied by a factor of 1.15 unless the dynamic effect of failure under static load are otherwise considered.

(c) The damage tolerance evaluation of 523.573(b).

(Change 523-4 (96-09-01))
(Change 523-5)

523.572 *[Metallic Wing, Empennage, And Associated Structures*

(a) [For normal, utility, and aerobatic category aeroplanes, the strength, detail design, and fabrication of those parts of the airframe structure whose failure would be catastrophic must be evaluated under one of the following unless it is shown that the structure, operating stress level, materials and expected uses are comparable, from a fatigue standpoint, to a similar design that has had extensive satisfactory service experience:

(1) [A fatigue strength investigation in which the structure is shown by tests, or by analysis supported by test evidence, to be able to withstand the repeated loads of variable magnitude expected in service; or]

(2) A fail safe strength investigation in which it is shown by analysis, tests, or both, that catastrophic failure of the structure is not probable after fatigue failure, or obvious partial failure, of a principal structural element, and that the remaining structure is able to withstand a static ultimate load factor of 75 percent of the critical limit load at V_C. These loads must be multiplied by a factor of 1.15 unless the dynamic effects of failure under static load are otherwise considered.

(3) The damage tolerance evaluation of 523.573(b).

(b) Each evaluation required by this section must:

(1) Include typical loading spectra (e.g. taxi, ground-air-ground cycles, manoeuvre, gust);

(2) Account for any significant effects due to the mutual influence of aerodynamic surfaces; and

(3) Consider any significant effects from propeller slipstream loading, and buffet from vortex impingements.

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))
(Change 523-4 (96-09-01))
(Change 523-5)

523.573 *Damage Tolerance and Fatigue Evaluation of Structure*

(a) *Composite airframe structure.* Composite airframe structure must be evaluated under this paragraph instead of 523.571 and 523.572. The applicant must evaluate the composite airframe structure, the failure of which would result in catastrophic loss of the aeroplane, in each wing (including canards, tandem wings, and winglets), empennage, their carry-through and attaching structure, moveable control surfaces and their attaching structure, fuselage, and pressure cabin using the damage-tolerance criteria prescribed in paragraphs (a)(1) through (a)(4) of this section unless shown to be impractical. If the applicant establishes that damage-tolerance criteria is impractical for a particular structure, the structure must be evaluated in accordance with paragraphs (a)(1) and (a)(6) of this section. Where bonded joints are used, the structure must also be evaluated in accordance with paragraph (a)(5) of this section. The effects of material variability and environmental conditions on the strength and durability properties of the composite materials must be accounted for in the evaluations required by this section.

(1) It must be demonstrated by tests, or by analysis supported by tests, that the structure is capable of carrying ultimate load with damage up to the threshold of detectability considering the inspection procedures employed.

(2) The growth rate or no-growth of damage that may occur from fatigue, corrosion, manufacturing flaws or impact damage, under repeated loads expected in service, must be established by tests or analysis supported by tests.

(3) The structure must be shown by residual strength tests, or analysis supported by residual strength tests, to be able to withstand critical limit flight loads, considered as ultimate loads, with the extent of detectable damage consistent with the results of the damage tolerance evaluations. For pressurised cabins, the following loads must be withstood:

(i) Critical limit flight loads with the combined effects of normal operating pressure and expected external aerodynamic pressures.

(ii) The expected external aerodynamic pressures in 1g flight combined with a cabin differential pressure equal to 1.1 times the normal operating differential pressure without any other load.

(4) The damage growth, between initial detectability and the value selected for residual strength demonstrations, factored to obtain inspection intervals, must allow development of an inspection program suitable for application by operation and maintenance personnel.

(5) For any bonded joint, the failure of which would result in catastrophic loss of the aeroplane, the limit load capacity must be substantiated by one of the following methods:

(i) The maximum disbonds of each bonded joint consistent with the capability to withstand the loads in paragraph (a)(3) of this section must be determined by analysis, tests, or both. Disbonds of each bonded joint greater than this must be prevented by design features; or

(ii) Proof testing must be conducted on each production article that will apply the critical limit design load to each critical bonded joint; or

(iii) Repeatable and reliable non-destructive inspection techniques must be established that ensure the strength of each joint.

(6) Structural components for which the damage tolerance method is shown to be impractical must be shown by component fatigue tests, or analysis supported by tests, to be able to withstand the repeated loads of variable magnitude expected in service. Sufficient component, subcomponent, element, or coupon tests must be done to establish the fatigue scatter factor and the environmental effects. Damage up to the threshold of detectability and ultimate load residual strength capability must be considered in the demonstration.

(b) Metallic airframe structure. If the applicant elects to use 523.571(c) or 523.572(a)(3), then the damage tolerance evaluation must include a determination of the probable locations and modes of damage due to fatigue, corrosion, or accidental damage. The determination must be by analysis supported by test evidence and, if available, service experience. Damage at multiple sites due to fatigue must be included where the design is such that this type of damage can be expected to occur. The evaluation must incorporate repeated load and static analyses supported by test evidence. The extent of damage for residual strength evaluation at any time within the operational life of the aeroplane must be consistent with the initial detectability and subsequent growth under repeated loads. The residual strength evaluation must show that the remaining structure is able to withstand critical limit flight loads, considered as ultimate, with the extent of detectable damage consistent with the results of the damage tolerance evaluations. For pressurised cabins, the following load must be withstood:
(amended 2010/01/29)

(1) The normal operating differential pressure combined with the expected external aerodynamic pressures applied simultaneously with the flight loading conditions specified in this chapter, and

(2) The expected external aerodynamic pressures in 1g flight combined with a cabin differential pressure equal to 1.1 times the normal operating differential pressure without any other load.

(c) Removed

(Change 523-4 (96-09-01))
(Change 523-5)

523.574 *Metallic Damage Tolerance And Fatigue Evaluation Of Commuter Category Aeroplanes*

For commuter category aeroplanes:

(a) Metallic damage tolerance. An evaluation of the strength, detail design, and fabrication must show that catastrophic failure due to fatigue, corrosion, defects, or damage will be avoided throughout the operational life of the aeroplane. This evaluation must be conducted in accordance with the provisions of 523.573, except as specified in paragraph (b) of this section, for each part of the structure that could contribute to a catastrophic failure.

[(b) *Fatigue (safe-life) evaluation.* Compliance with the damage tolerance requirements of paragraph (a) of this section is not required if the applicant establishes that the application of those requirements is impractical for a particular structure. This structure must be shown, by analysis supported by test evidence, to be able to withstand the repeated loads of variable magnitude expected during its service life without detectable cracks. Appropriate safe-life scatter factors must be applied.]

(Change 523-5)

[523.575 *Inspections And Other Procedures*

[Each inspection or other procedure, based on an evaluation required by 523.571, 523.572, 523.573 or 523.574, must be established to prevent catastrophic failure and must be included in the Limitations Section of the Instructions for Continued Airworthiness required by 523.1529.]

(Change 523-5)

SUBCHAPTER D

Design and Construction - General

523.601 *General*

The suitability of each questionable design detail and part having an important bearing on safety in operations, must be established by tests.

523.603 *Materials and Workmanship*

(a) The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must:

(1) Be established by experience or tests;

(2) Meet approved specifications that ensure their having the strength and other properties assumed in the design data; and

(3) Take into account the effects of environmental conditions, such as temperature and humidity, expected in service.

(b) Workmanship must be of a high standard.

523.605 *Fabrication Methods*

(a) The methods of fabrication used must produce consistently sound structures. If a fabrication process (such as gluing, spot welding, or heat-treating) requires close control to reach this objective, the process must be performed under an approved process specification.

(b) Each new aircraft fabrication method must be substantiated by a test program.

523.607 *[Fasteners*

[(a) Each removable fastener must incorporate two retaining devices if the loss of such fastener would preclude continued safe flight and landing.

[(b) Fasteners and their locking devices must not be adversely affected by the environmental conditions associated with the particular installation.

[(c) No self-locking nut may be used on any bolt subject to rotation in operation unless a non-friction locking device is used in addition to the self-locking device.]

(Change 523-5)

523.609 *Protection of Structure*

Each part of the structure must:

(a) Be suitably protected against deterioration or loss of strength in service due to any cause, including:

(1) Weathering;

(2) Corrosion; and

(3) Abrasion; and

(b) Have adequate provisions for ventilation and drainage.

523.611 *[Accessibility Provisions*

[For each part that requires maintenance, inspection, or other servicing, appropriate means must be incorporated into the aircraft design to allow such servicing to be accomplished.]

(Change 523-5)

523.613 *Material Strength Properties and Design Values*

(a) Material strength properties must be based on enough tests of material meeting specifications to establish design values on a statistical basis.

(b) Design values must be chosen to minimize the probability of structural failure due to material variability. Except as provided in paragraph (e) of this section, compliance with this paragraph must be shown by selecting design values that ensure material strength with the following probability:

(1) Where applied loads are eventually distributed through a single member within an assembly, the failure of which would result in loss of structural integrity of the component; 99 percent probability with 95 percent confidence.

(2) For redundant structure, in which the failure of individual elements would result in applied loads being safely distributed to other load carrying members; 90 percent probability with 95 percent confidence.

(c) The effects of temperature on allowable stresses used for design in an essential component or structure must be considered where thermal effects are significant under normal operating conditions.

(d) The design of the structure must minimize the probability of catastrophic fatigue failure, particularly at points of stress concentration.

(e) Design values greater than the guaranteed minimums required by this section may be used where only guaranteed minimum values are normally allowed if a "premium selection" of the material is made in which a specimen of each individual item is tested before use to determine that the actual strength properties of that particular item will equal or exceed those used in design.

(Change 523-4 (96-09-01))

523.615 *Design Properties (Removed)*

(Change 523-4 (96-09-01))

523.619 *Special Factors*

The factor of safety prescribed in 523.303 must be multiplied by the highest pertinent special factors of safety prescribed in 523.621 through 523.625 for each part of the structure whose strength is:

(1) Uncertain;

(2) Likely to deteriorate in service before normal replacement; or

(3) Subject to appreciable variability because of uncertainties in manufacturing processes or inspection methods.

523.621 *Casting Factors*

(a) *General.* The factors, tests, and inspections specified in paragraphs (b) through (d) of this section must be applied in addition to those necessary to establish foundry quality control. The inspections must meet approved specifications. Paragraphs (c) and (d) of this section apply to any structural castings except castings that are pressure tested as parts of hydraulic or other fluid systems and do not support structural loads.

(b) *Bearing stresses and surfaces.* The casting factors specified in paragraphs (c) and (d) of this section:

(1) Need not exceed 1.25 with respect to the bearing stresses regardless of the method of inspection used; and

(2) Need not be used with respect to the bearing surfaces of a part whose bearing factor is larger than the applicable casting factor.

(c) *Critical castings.* For each casting whose failure would preclude continued safe flight and landing of the aeroplane or result in serious injury to occupants, the following apply:

(1) Each critical casting must either:

(i) Have a casting factor of not less than 1.25 and receive 100 percent inspection by visual, radiographic, and either magnetic particle, penetrant or other approved equivalent non-destructive inspection method; or

(ii) Have a casting factor of not less than 2.0 and receive 100 percent visual inspection and 100 percent approved non-destructive inspection. When an approved quality control procedure is established and an acceptable statistical analysis supports reduction, non-destructive inspection may be reduced from 100 percent, and applied on a sampling basis.

(2) For each critical casting with a casting factor less than 1.50, three sample castings must be static tested and shown to meet:

(i) The strength requirements of 523.305 at an ultimate load corresponding to a casting factor of 1.25; and

(ii) The deformation requirements of 523.305 at a load of 1.15 times the limit load.

(3) Examples of these castings are structural attachment fittings, parts of flight control systems, control surface hinges and balance weight attachments, seat, berth, safety belt, and fuel and oil tank supports and attachments, and cabin pressure valves.

(d) *Non-critical castings.* For each casting other than those specified in paragraph (c) or (e) of this section, the following apply:

(1) Except as provided in subparagraphs (2) and (3) of this paragraph, the casting factors and corresponding inspections must meet Table below.

Casting Factor	*Inspection*
2.0 or more	100 % visual.
Less than 2.0 but more than 1.5	100 % visual, and magnetic particle or penetrant or equivalent non-destructive inspection methods.
1.25 through 1.50	100 % visual, magnetic particle or penetrant, and radiographic, or approved equivalent non-destructive inspection methods.

(2) The percentage of castings inspected by non-visual methods may be reduced below that specified in subparagraph (1) of this paragraph when an approved quality control procedure is established.

(3) For castings procured to a specification that guarantees the mechanical properties of the material in the casting and provides for demonstration of these properties by test of coupons cut from the castings on a sampling basis:

(i) A casting factor of 1.0 may be used; and

(ii) The castings must be inspected as provided in subparagraph (1) of this paragraph for casting factors of "1.25 through 1.50" and tested under paragraph (c)(2) of this section.

(e) *Non-structural castings.* Castings used for non-structural purposes do not require evaluation, testing or close inspection.

(Change 523-4 (96-09-01))

523.623 *Bearing Factors*

(a) Each part that has clearance (free fit), and that is subject to pounding or vibration, must have a bearing factor large enough to provide for the effects of normal relative motion.

(b) For control surface hinges and control system joints, compliance with the factors prescribed in 523.657 and 523.693, respectively, meets paragraph (a) of this section.

523.625 *Fitting Factors*

For each fitting (a part or terminal used to join one structural member to another), the following apply:

(a) For each fitting whose strength is not proven by limit and ultimate load tests in which actual stress conditions are simulated in the fitting and surrounding structure, a fitting factor of at least 1.15 must be applied to each part of:

(1) The fitting;

(2) The means of attachment; and

(3) The bearing on the joined members.

(b) No fitting factor need be used for joint designs based on comprehensive test data (such as continuous joints in metal plating, welded joints, and scarf joints in wood).

(c) For each integral fitting, the part must be treated as a fitting up to the point at which the section properties become typical of the member.

(d) For each seat, berth, safety belt, and harness, its attachment to the structure must be shown, by analysis, tests, or both, to be able to withstand the inertia forces prescribed in 523.561 multiplied by a fitting factor of 1.33.

523.627 *Fatigue Strength*

The structure must be designed, as far as practicable, to avoid points of stress concentration where variable stresses above the fatigue limit are likely to occur in normal services.

523.629 *Flutter*

(a) [It must be shown by the methods of paragraph (b) and either paragraph (c) or (d) of this section, that the aeroplane is free from flutter, control reversal, and divergence for any condition of operation within the limit V-n envelope and at all speeds up to the speed specified for the selected method. In addition:]

(1) Adequate tolerances must be established for quantities which affect flutter, including speed, damping, mass balance, and control system stiffness; and

(2) The natural frequencies of main structural components must be determined by vibration tests or other approved methods.

(b) [Flight flutter tests must be made to show that the aeroplane is free from flutter, control reversal and divergence and to show that:

[(1) Proper and adequate attempts to induce flutter have been made within the speed range up to V_D;

[(2) The vibratory response of the structure during the test indicates freedom from flutter;

[(3) A proper margin of damping exists at V_D; and

[(4) There is no large and rapid reduction in damping as V_D is approached.

(c) [Any rational analysis used to predict freedom from flutter, control reversal and divergence must cover all speeds up to 1.2 V_D.]

(d) Compliance with the rigidity and mass balance criteria (pages 4-12), in Airframe and Equipment Engineering Report No. 45 (as corrected) "Simplified Flutter Prevention Criteria" (published by the Federal Aviation Administration U.S.A.) may be accomplished to show that the aeroplane is free from flutter, control reversal, or divergence if:

(1) V_D/M_D for the aeroplane is less than 260 knots (EAS) and less than Mach 0.5,

(2) The wing and aileron flutter prevention criteria, as represented by the wing torsional stiffness and aileron balance criteria, are limited in use to aeroplanes without large mass concentrations (such as engines, floats, or fuel tanks in outer wing panels) along the wing span, and

(3) The aeroplane:

(i) [Does not have a T-tail or other unconventional tail configurations;]

(ii) Does not have unusual mass distributions or other unconventional design features that affect the applicability of the criteria, and

(iii) Has fixed-fin and fixed-stabiliser surfaces.

(e) For turbopropeller-powered aeroplanes, the dynamic evaluation must include:

(1) Whirl mode degree of freedom which takes into account the stability of the plane of rotation of the propeller and significant elastic, inertial, and aerodynamic forces, and

(2) Propeller, engine, engine mounts, and aeroplane structure stiffness and damping variations appropriate to the particular configuration.

(f) Freedom from flutter, control reversal, and divergence up to V_D/M_D must be shown as follows:

(1) For aeroplanes that meet the criteria of paragraphs (d)(1) through (d)(3) of this section, after the failure, malfunction, or disconnection of any single element in any tab control system.

(2) For aeroplanes other than those described in paragraph (f)(1) of this section, after the failure, malfunction, or disconnection of any single element in the primary flight control system, any tab control system, or any flutter damper.

(g) [For aeroplanes showing compliance with the fail-safe criteria of 523.571 and 523.572, the aeroplane must be shown by analysis to be free from flutter up to V_D/M_D after fatigue failure, or obvious partial failure, of a principal structural element.

(h) [For aeroplanes showing compliance with the damage tolerance criteria of 523.573, the aeroplane must be shown by analysis to be free from flutter up to V_D/M_D with the extent of damage for which residual strength is demonstrated.

[(i) For modifications to the type design that could affect the flutter characteristics, compliance with paragraph (a) of this section must be shown, except that analysis based on previously approved data may be used alone to show freedom from flutter, control reversal and divergence, for all speeds up to the speed specified for the selected method.]

(Change 523-4 (96-09-01))
(Change 523-5)

Wings

523.641 *Proof of Strength*

The strength of stressed-skin wings must be proven by load tests or by combined structural analysis and load tests.

Control Surfaces

523.651 *Proof of Strength*

(a) Limit load tests of control surfaces are required. These tests must include the horn or fitting to which the control system is attached.

(b) In structural analyses, rigging loads due to wire bracing must be accounted for in a rational or conservative manner.

523.655 *Installation*

(a) Movable surfaces must be installed so that there is no interference between any surfaces, their bracing, or adjacent fixed structure, when one surface is held in its most critical clearance positions and the others are operated through their full movement.

(b) If an adjustable stabiliser is used, it must have stops that will limit its range of travel to that allowing safe flight and landing.

(Change 523-4 (96-09-01))

523.657 *Hinges*

(a) Control surface hinges, except ball and roller bearing hinges, must have a factor of safety of not less than 6.67 with respect to the ultimate bearing strength of the softest material used as a bearing.

(b) For ball or roller bearing hinges, the approved rating of the bearing may not be exceeded.

(c) [Removed]

(Change 523-5)

523.659 *Mass Balance*

The supporting structure and the attachment of concentrated mass balance weights used on control surfaces must be designed for:

(a) 24g normal to the plane of the control surface;

(b) 12g fore and aft; and

(c) 12g parallel to the hinge line.

Control Systems

523.671 *General*

(a) Each control must operate easily, smoothly, and positively enough to allow proper performance of its functions.

(b) Controls must be arranged and identified to provide for convenience in operation and to prevent the possibility of confusion and subsequent inadvertent operation.

523.672 *Stability Augmentation and Automatic and Power-Operated Systems*

If the functioning of stability augmentation or other automatic or power-operated systems is necessary to show compliance with the flight characteristics requirements of this Chapter, such systems must comply with 523.671 and the following:

(a) A warning, which is clearly distinguishable to the pilot under expected flight conditions without requiring the pilot's attention, must be provided for any failure in the stability augmentation system or in any other automatic or power-operated system that could result in an unsafe condition if the pilot was not aware of the failure. Warning systems must not activate the control system.

(b) The design of the stability augmentation system or of any other automatic or power-operated system must permit initial counteraction of failures without requiring exceptional pilot skill or strength, by either the deactivation of the system or a failed portion thereof, or by overriding the failure by movement of the flight controls in the normal sense.

(c) It must be shown that, after any single failure of the stability augmentation system or any other automatic or power-operated system:

(1) The aeroplane is safely controllable when the failure or malfunction occurs at any speed or altitude within the approved operating limitations that is critical for the type of failure being considered;

(2) The controllability and manoeuvrability requirements of this part are met within a practical operational flight envelope (for example, speed, altitude, normal acceleration, and aeroplane configuration) that is described in the Aeroplane Flight Manual (AFM); and

(3) The trim, stability, and stall characteristics are not impaired below a level needed to permit continued safe flight and landing.

(Change 523-4 (96-09-01))

523.673 *Primary Flight Controls*

Primary flight controls are those used by the pilot for the immediate control of pitch, roll, and yaw.

(b) [Removed]

(Change 523-5)

523.675 *Stops*

(a) Each control system must have stops that positively limit the range of motion of each movable aerodynamic surface controlled by the system.

(b) Each stop must be located so that wear, slackness, or take-up adjustments will not adversely affect the control characteristics of the aeroplane because of a change in the range of surface travel.

(c) Each stop must be able to withstand any loads corresponding to the design conditions for the control system.

523.677 *Trim Systems*

(a) [Proper precautions must be taken to prevent inadvertent, improper, or abrupt trim tab operation. There must be means near the trim control to indicate to the pilot the direction of trim control movement relative to aeroplane motion. In addition, there must be means

to indicate to the pilot the position of the trim device with respect to both the range of adjustment and, in the case of lateral and directional trim, the neutral position. This means must be visible to the pilot and must be located and designed to prevent confusion. The pitch trim indicator must be clearly marked with a position or range within which it has been demonstrated that takeoff is safe for all centre of gravity positions and each flap position approved for takeoff.]

(b) Trimming devices must be designed so that, when any one connecting or transmitting element in the primary flight control system fails, adequate control for safe flight and landing is available with:

(1) For single-engine aeroplanes, the longitudinal trimming devices; or

(2) For multi-engine aeroplanes, the longitudinal and directional trimming devices.

(c) Tab controls must be irreversible unless the tab is properly balanced and has no unsafe flutter characteristics. Irreversible tab systems must have adequate rigidity and reliability in the portion of the system from the tab to the attachment of the irreversible unit to the aeroplane structure.

(d) It must be demonstrated that the aeroplane is safely controllable and that the pilot can perform all manoeuvres and operations necessary to effect a safe landing following any probable powered trim system runaway that reasonably might be expected in service, allowing for appropriate time delay after pilot recognition of the trim system runaway. The demonstration must be conducted at critical aeroplane weights and centre of gravity positions.

(Change 523-3 (92-01-02))
(Change 523-5)

523.679 *Control System Locks*

If there is a device to lock the control system on the ground or water:

(a) There must be a means to:

(1) Give unmistakable warning to the pilot when lock is engaged; or

(2) Automatically disengage the device when the pilot operates the primary flight controls in a normal manner.

(b) The device must be installed to limit the operation of the aeroplane so that, when the device is engaged, the pilot receives unmistakable warning at the start of the takeoff.

(c) The device must have a means to preclude the possibility of it becoming inadvertently engaged in flight.

(Change 523-4 (96-09-01))

523.681 *Limit Load Static Tests*

(a) Compliance with the limit load requirements of this Chapter must be shown by tests in which:

(1) The direction of the test loads produces the most severe loading in the control system; and

(2) Each fitting, pulley, and bracket used in attaching the system to the main structure is included.

(b) Compliance must be shown (by analyses or individual load tests) with the special factor requirements for control system joints subject to angular motion.

523.683 *Operation Tests*

(a) It must be shown by operation tests that, when the controls are operated from the pilot compartment with the system loaded as prescribed in paragraph (b) of this section, the system is free from:

(1) Jamming;

(2) Excessive friction; and

(3) Excessive deflection.

(b) The prescribed test loads are:

(1) For the entire system, loads corresponding to the limit airloads on the appropriate surface, or the limit pilot forces in 523.397 (b), whichever are less; and

(2) For secondary controls, loads not less than those corresponding to the maximum pilot effort established under 523.405.

523.685 *Control System Details*

(a) Each detail of each control system must be designed and installed to prevent jamming, chafing, and interference from cargo, passengers, loose objects, or the freezing of moisture.

(b) There must be means in the cockpit to prevent the entry of foreign objects into places where they would jam the system.

(c) There must be means to prevent the slapping of cables or tubes against other parts.

(d) Each element of the flight control system must have design features, or must be distinctively and permanently marked, to minimize the possibility of incorrect assembly that could result in malfunctioning of the control system.

523.687 *Spring Devices*

The reliability of any spring device used in the control system must be established by tests simulating service conditions unless failure of the spring will not cause flutter or unsafe flight characteristics.

523.689 *Cable Systems*

(a) Each cable, cable fitting, turnbuckle, splice, and pulley used must meet approved specifications. In addition:

(1) No cable smaller than 1/8 inch diameter may be used in primary control systems;

(2) Each cable system must be designed so that there will be no hazardous change in cable tension throughout the range of travel under operating conditions and temperature variations; and

(3) There must be means for visual inspection at each fairlead, pulley, terminal, and turnbuckle.

(b) Each kind and size of pulley must correspond to the cable with which it is used. Each pulley must have closely fitted guards to prevent the cables from being misplaced or fouled, even when slack. Each pulley must lie in the plane passing through the cable so that the cable does not rub against the pulley flange.

(c) Fairleads must be installed so that they do not cause a change in cable direction of more that 3°.

(d) Clevis pins subject to load or motion and retained only by cotter pins may not be used in the control system.

(e) Turnbuckles must be attached to parts having angular motion in a manner that will positively prevent binding throughout the range of travel.

(f) Tab control cables are not part of the primary control system and may be less than 1/8 inch diameter in aeroplanes that are safely controllable with the tabs in the most adverse positions.

[523.691 *Artificial Stall Barrier System*

[If the function of an artificial stall barrier, for example, stick pusher, is used to show compliance with 523.201(c), the system must comply with the following:

[(a) With the system adjusted for operation, the plus and minus airspeeds at which downward pitching control will be provided must be established.

[(b) Considering the plus and minus airspeed tolerances established by paragraph (a) of this section, an airspeed must be selected for the activation of the downward pitching control that provides a safe margin above any airspeed at which any unsatisfactory stall characteristics occur.

[(c) In addition to the stall warning required by 523.07, a warning that is clearly distinguishable to the pilot under all expected flight conditions without requiring the pilot's attention, must be provided for faults that would prevent the system from providing the required pitching motion.

[(d) Each system must be designed so that the artificial stall barrier can be quickly and positively disengaged by the pilots to prevent unwanted downward pitching of the aeroplane by a quick release (emergency) control that meets the requirements of 523.1329(b).

[(e) A pre-flight check of the complete system must be established and the procedure for this check made available in the Aeroplane Flight Manual (AFM). Pre-flight checks that are critical to the safety of the aeroplane must be included in the limitations section of the AFM.

[(f) For those aeroplanes whose design includes an auto-pilot system:

[(1) A quick release (emergency) control installed in accordance with 523.1329(b) may be used to meet the requirements of paragraph (d), of this section, and

[(2) The pitch servo for that system may be used to provide the stall downward pitching motion.

[(g) In showing compliance with 523.1309, the system must be evaluated to determine the effect that any announced or unannounced failure may have on the continued safe flight and landing of the aeroplane or the ability of the crew to cope with any adverse conditions that may result from such failures. This evaluation must consider the hazards that would result from the aeroplane's flight characteristics if the system was not provided, and the hazard that may result from unwanted downward pitching motion, which could result from a failure at airspeeds above the selected stall speed.]

(Change 523-5)

523.693 *Joints*

Control system joints (in push-pull systems) that are subject to angular motion, except those in ball and roller bearing systems, must have a special factor of safety of not less than 3.33 with respect to the ultimate bearing strength of the softest material used as a bearing. This factor may be reduced to 2.0 for joints in cable control systems. For ball or roller bearings, the approved ratings may not be exceeded.

523.697 *Wing Flap Controls*

(a) Each wing flap control must be designed so that, when the flap has been placed in any position upon which compliance with the performance requirements of this Chapter is based, the flap will not move from that position unless the control is adjusted or is moved by the automatic operation of a flap load limiting device.

(b) The rate of movement of the flaps in response to the operation of the pilot's control or automatic device must give satisfactory flight and performance characteristics under steady or changing conditions of airspeed, engine power, and attitude.

[(c) If compliance with 523.145(b)(3) necessitates wing flap retraction to positions that are not fully retracted, the wing flap control lever settings corresponding to those positions must be positively located such that a definite change of direction of movement of the lever is necessary to select settings beyond those settings.]

(Change 523-5)

523.699 *Wing Flap Position Indicator*

There must be a wing flap position indicator for:

(a) Flap installations with only the retracted and fully extended position, unless:

(1) A direct operating mechanism provides a sense of "feel" and position (such as when a mechanical linkage is employed); or

(2) The flap position is readily determined without seriously detracting from other piloting duties under any flight condition, day or night; and

(b) Flap installation with intermediate flap positions if:

(1) Any flap position other than retracted or fully extended is used to show compliance with the performance requirements of this Chapter; and

(2) The flap installation does not meet the requirements of paragraph (a)(1) of this section.

523.701 *Flap Interconnection*

(a) The main wing flaps and related movable surfaces as a system must:

(1) [Be synchronized by a mechanical interconnection between the movable flap surfaces that is independent of the flap drive system; or by an approved equivalent means; or

(2) [Be designed so that the occurrence of any failure of the flap system that would result in an unsafe flight characteristic of the aeroplane is extremely improbable; or]

(b) The aeroplane must be shown to have safe flight characteristics with any combination of extreme positions of individual movable surfaces (mechanically interconnected surfaces are to be considered as a single surface).

(c) If any interconnection is used in multi-engine aeroplanes, it must be designed to account for the unsymmetrical loads resulting from flight with the engines on one side of the plane of symmetry inoperative and the remaining engines at takeoff power. For single-engine aeroplanes, and multi-engine aeroplanes with no slipstream effects on the flaps, it may be assumed that 100 percent of the critical air load acts on one side and 70 percent on the other.

(Change 523-3 (92-01-02))
(Change 523-5)

[523.703 *Takeoff Warning System*

[For commuter category aeroplanes, unless it can be shown that a lift or longitudinal trim device that affects the takeoff performance of the aircraft would not give an unsafe takeoff configuration when selection out of an approved takeoff position, a takeoff warning system must be installed and meet the following requirements:

[(a) The system must provide to the pilots an aural warning that is automatically activated during the initial portion of the takeoff role if the aeroplane is in a configuration that would not allow a safe takeoff. The warning must continue until:

[(1) The configuration is changed to allow safe takeoff, or

[(2) Action is taken by the pilot to abandon the takeoff roll.

[(b) The means used to activate the system must function properly for all authorized takeoff power settings and procedures and throughout the ranges of takeoff weights, altitudes, and temperatures for which certification is requested.]

(Change 523-5)

Landing Gear

523.721 *General*

For commuter category aeroplanes that have a passenger seating configuration, excluding pilot seats, of 10 or more, the following general requirements for the landing gear apply:

(a) The main landing-gear system must be designed so that if it fails due to overloads during takeoff and landing (assuming the overloads to act in the upward and aft directions), the failure mode is not likely to cause the spillage of enough fuel from any part of the fuel system to constitute a fire hazard.

(b) Each aeroplane must be designed so that, with the aeroplane under control, it can be landed on a paved runway with any one or more landing-gear legs not extended without sustaining a structural component failure that is likely to cause the spillage of enough fuel to constitute a fire hazard.

(c) Compliance with the provisions of this section may be shown by analysis or tests, or both.

(Change 523-1(88-01-01))

523.723 *Shock Absorption Tests*

(a) It must be shown that the limit load factors selected for design in accordance with 523.473 for takeoff and landing weights, respectively, will not be exceeded. This must be shown by energy absorption tests except that analysis based on tests conducted on a landing gear system with identical energy absorption characteristics may be used for increases in previously approved takeoff and landing weights.

(b) **[**The landing gear may not fail, but may yield, in a test showing its reserve energy absorption capacity, simulating a descent velocity of 1.2 times the limit descent velocity, assuming wing lift equal to the weight of the aeroplane.**]**

(Change 523-5)

523.725 *Limit Drop Tests*

(a) If compliance with 523.723 (a) is shown by free drop tests, these tests must be made on the complete aeroplane, or on units consisting of wheel, tire, and shock absorber, in their proper relation, from free drop heights not less than those determined by the following formula:

$$h \text{ (inches)} = 3.6 \, (W/S)^{1/2}$$

However, the free drop height may not be less than 9.2 inches and need not be more than 18.7 inches.

(b) If the effect of wing lift is provided for in free drop tests, the landing gear must be dropped with an effective weight equal to

$$\left[W_e = W \frac{[h + (1 - L)d\,]}{(h + d)} \right]$$

where:

W_e = the effective weight to be used in the drop test (lbs.);

h = specified free drop height (inches);

d = deflection under impact of the tire (at the approved inflation pressure) plus the vertical component of the axle travel relative to the drop mass (inches);

$W = W_M$ for main gear units (lbs.), equal to the static weight on that unit with the aeroplane in the level attitude (with the nose wheel clear in the case of nose wheel type aeroplanes);

$W = W_T$ for tail gear units (lbs.), equal to the static weight on the tail unit with the aeroplane in the tail-down attitude;

$W = W_N$ for nose wheel units (lbs.), equal to the vertical component of the static reaction that would exist at the nose wheel, assuming that the mass of the aeroplane acts at the centre of gravity and exerts a force of 1.0g downward and 0.33g forward; and

L = the ratio of the assumed wing lift to the aeroplane weight, but not more than 0.667.

(c) The limit inertia load factor must be determined in a rational or conservative manner, during the drop test, using a landing gear unit attitude, and applied drag loads, that represent the landing conditions.

(d) The value of "d" used in the computation of W_e in paragraph (b) of this section may not exceed the value actually obtained in the drop test.

(e) The limit inertia load factor must be determined from the drop test in paragraph (b) of this section according to the following formula:

$$n = n_j \frac{W_e}{W} + L$$

where:

n_j = the load factor developed in the drop test (that is, the acceleration (dv/dt) in g's recorded in the drop test) plus 1.0; and

W_e, W, and L are the same as in the drop test computation.

(f) The value of n determined in accordance with paragraph (e) may not be more than the limit inertia load factor used in the landing conditions in 523.473.

(Change 523-5)

523.726 *Ground Load Dynamic Tests*

(a) If compliance with the ground load requirements of 523.479 through 523.483 is shown dynamically by drop test, one drop test must be conducted that meets 523.725 except that the drop height must be:

(1) 2.25 times the drop height prescribed in 523.725 (a); or

(2) Sufficient to develop 1.5 times the limit load factor.

(b) The critical landing condition for each of the design conditions specified in 523.479 through 523.483 must be used for proof of strength.

523.727 *Reserve Energy Absorption Drop Tests*

(a) If compliance with the reserve energy absorption requirement in 523.723(b) is shown by free drop tests, the drop height may not be less than 1.44 times that specified in 523.725.

(b) If the effect of wing lift is provided for, the units must be dropped with an effective mass equal to

$$W_e = W\left(\frac{h}{h+d}\right).$$

when the symbols and other details are the same as in 523.725.

523.729 *Landing Gear Extension and Retraction System*

(a) *General.* For aeroplanes with retractable landing gear, the following apply:

(1) Each landing gear retracting mechanism and its supporting structure must be designed for maximum flight load factors with the gear retracted and must be designed for the combination of friction, inertia, brake torque, and air loads, occurring during retraction at any airspeed up to 1.6 V_{S1} with flaps retracted, and for any load factor up to those specified in 523.345 for the flaps-extended condition.

(2) The landing gear and retracting mechanism, including the wheel well doors, must withstand flight loads, including loads resulting from all yawing conditions specified in 523.351, with the landing gear extended at any speed up to at least 1.6 V_{S1} with the flaps retracted.

(b) *Landing gear lock.* There must be positive means (other than the use of hydraulic pressure) to keep the landing gear extended.

(c) *Emergency operation.* For a landplane having retractable landing gear that cannot be extended manually, there must be means to extend the landing gear in the event of either:

(1) Any reasonably probable failure in the normal landing gear operation system; or

(2) Any reasonably probable failure in a power source that would prevent the operation of the normal landing gear operation system.

(d) *Operation test.* The proper functioning of the retracting mechanism must be shown by operation tests.

(e) [*Position indicator.* If a retractable landing gear is used, there must be a landing gear position indicator (as well as necessary switches to actuate the indicator) or other means to inform the pilot that each gear is secured in the extended (or retracted) position. If switches are used, they must be located and coupled to the landing gear mechanical system in a manner that prevents an erroneous indication of either "down and locked" if each gear is not in the fully extended position, or "up and locked" if each landing gear is not in the fully retracted position.]

(f) *Landing gear warning.* For landplanes, the following aural or equally effective landing gear warning devices must be provided:

(1) A device that functions continuously when one or more throttles are closed beyond the power settings normally used for landing approach if the landing gear is not fully extended and locked. A throttle stop may not be used in place of an aural device. If there is a manual shutoff for the warning device prescribed in this paragraph, the warning system must be designed so that when the warning has been suspended after one or more throttles are closed, subsequent retardation of any throttle to, or beyond, the position for normal landing approach will activate the warning device.

(2) A device that functions continuously when the wing flaps are extended beyond the maximum approach flap position, using a normal landing procedure, if the landing gear is not fully extended and locked. There may not be a manual shut-off for this warning device. The flap position sensing unit may be installed at any suitable location. The system for this device may use any part of the system (including the aural warning device) for the device required in paragraph (f)(1) of this section.

[(g) *Equipment located in the landing gear bay.* If the landing gear bay is used as the location for equipment other than the landing gear, that equipment must be designed and installed to minimize damage from items such as a tire burst, or rocks, water, and slush that may enter the landing gear bay.**]**

(Change 523-4 (96-09-01))
(Change 523-5)

523.731 *Wheels*

(a) The maximum static load rating of each wheel may not be less than the corresponding static ground reaction with:

(1) Design maximum weight; and

(2) Critical centre of gravity.

(b) The maximum limit load rating of each wheel must equal or exceed the maximum radial limit load determined under the applicable ground load requirements of this Chapter.

(Change 523-4 (96-09-01))

523.733 *Tires*

(a) Each landing gear wheel must have a tire whose approved tire ratings (static and dynamic) are not exceeded:

(1) By a load on each main wheel tire (to be compared to the static rating approved for such tires) equal to the corresponding static ground reaction under the design maximum weight and critical centre of gravity; and

(2) By a load on nose wheel tires (to be compared with the dynamic rating approved for such tires) equal to the reaction obtained at the nose wheel, assuming the mass of the aeroplane to be concentrated at the most critical centre of gravity and exerting a force of 1.0 W downward and 0.31 W forward (where W is the design maximum

weight), with the reactions distributed to the nose and main wheels by the principles of statics and with the drag reaction at the ground applied only at wheels with brakes.

(b) If specially constructed tires are used, the wheels must be plainly and conspicuously marked to that effect. The markings must include the make, size, number of plies, and identification marking of the proper tire.

(c) Each tire installed on a retractable landing gear system must, at the maximum size of the tire type expected in service, have a clearance to surrounding structure and systems that is adequate to prevent contact between the tire and any part of the structure or systems.

(Change 523-4 (96-09-01))

523.735 *Brakes*

(a) [Brakes must be provided. The landing brake kinetic energy capacity rating of each main wheel brake assembly must not be less than the kinetic energy absorption requirements determined under either of the following methods:]

(1) The brake kinetic energy absorption requirements must be based on a conservative rational analysis of the sequence of events expected during landing at the design landing weight.

(2) Instead of a rational analysis, the kinetic energy absorption requirements for each main wheel brake assembly may be derived from the following formula:

$$KE = \frac{0.0443 WV^2}{N}$$

where:

KE = Kinetic energy per wheel (ft. lb.);

W = Design landing weight (lb.);

V = Aeroplane speed in knots. V must be not less than V_{SO}, the power-off stalling speed of the aeroplane at sea level, at the design landing weight, and in the landing configuration; and

N = Number of main wheels with brakes.

(b) Brakes must be able to prevent the wheels from rolling on a paved runway with takeoff power on the critical engine, but need not prevent movement of the aeroplane with wheels locked.

(c) [During the landing distance determination required by 523.75, the pressure on the wheel braking system must not exceed the pressure specified by the brake manufacturer.]

[(d)] If antiskid devices are installed, the devices and associated systems must be designed so that no single probable malfunction or failure will result in a hazardous loss of braking ability or directional control of the aeroplane.

[(e) In addition, for commuter category aeroplanes, the rejected takeoff brake kinetic energy capacity rating of each main wheel brake assembly must not be less than the kinetic energy absorption requirements determined under either of the following methods:

[(1) The brake kinetic energy absorption requirements must be based on a conservative rational analysis of the sequence of events expected during a rejected takeoff at the design takeoff weight.

[(2) Instead of a rational analysis, the kinetic energy absorption requirements for each main wheel brake assembly may be derived from the following formula:

$$KE = \frac{0.0443\,WV^2}{N}$$

where,

KE = Kinetic energy per wheel (ft.-lbs.);

W = Design takeoff weight (lbs.);

V = Ground speed, in knots, associated with the maximum value of V_1 selected in accordance with 523.51(c)(1);

N = Number of main wheels with brakes.]

(Change 523-3 (92-01-02))
(Change 523-5)

523.737 *Skis*

The maximum limit load rating for each ski must equal or exceed the maximum limit load determined under the applicable ground load requirements of this chapter.

(Change 523-4 (96-09-01))

[523.745 *Nose/Tail Wheel Steering.*

[(a) If nose/tail wheel steering is installed, it must be demonstrated that its use does not require exceptional pilot skill during takeoff and landing, in crosswinds, or in the event of an engine failure; or its use must be limited to low speed manoeuvring.

[(b) Movement of the pilot's steering control must not interfere with the retraction or extension of the landing gear.]

(Change 523-5)

Floats and Hulls

523.751 *Main Float Buoyancy*

(a) Each main float must have:

(1) A buoyancy of 80 percent in excess of the buoyancy required by that float to support its portion of the maximum weight of the seaplane or amphibian in fresh water; and

(2) Enough watertight compartments to provide reasonable assurance that the seaplane or amphibian will stay afloat without capsizing if any two compartments of any main float are flooded.

(b) Each main float must contain at least four watertight compartments approximately equal in volume.

(Change 523-4 (96-09-01))

523.753 *Main Float Design*

Each seaplane main float must meet the requirements of 523.521.

(Change 523-4 (96-09-01))

523.755 *Hulls*

(a) The hull of a hull seaplane or amphibian of 1,500 pounds or more maximum weight must have watertight compartments designed and arranged so that the hull, auxiliary floats, and tires (if used), will keep the aeroplane afloat, without capsizing, in fresh water when:

(1) For aeroplanes of 5,000 pounds or more maximum weight, any two adjacent compartments are flooded; and

(2) For aeroplanes of 1,500 pounds up to, but not including, 5,000 pounds maximum weight, any single compartment is flooded.

(b) [Watertight doors in bulkheads may be used for communication between compartments.]

(Change 523-4 (96-09-01))
(Change 523-5)

523.757 *Auxiliary Floats*

Auxiliary floats must be arranged so that when completely submerged in fresh water, they provide a righting moment of at least 1.5 times the upsetting moment caused by the seaplane or amphibian being tilted.

Personnel and Cargo Accommodations

523.771 *Pilot Compartment*

For each pilot compartment:

(a) The compartment and its equipment must allow each pilot to perform his duties without unreasonable concentration or fatigue;

(b) Where the flight crew are separated from the passengers by a partition, an opening or openable window or door must be provided to facilitate communication between flight crew and the passengers; and

(c) The aerodynamic controls listed in 523.779, excluding cables and control rods, must be located with respect to the propellers so that no part of the pilot or the controls lies in the region between the plane of rotation of any inboard propeller and the surface generated by a line passing through the centre of the propeller hub making an angle of 5° forward or aft of the plane of rotation of the propeller.

523.773 *Pilot Compartment View*

(a) Each pilot compartment must be:

(1) Arranged with sufficiently extensive, clear and undistorted view to enable the pilot to safely taxi, takeoff, approach, land, and perform any manoeuvres within the operating limitations of the aeroplane.

(2) Free from glare and reflections that could interfere with the pilot's vision. Compliance must be shown in all operations for which certification is requested; and

(3) Designed so that each pilot is protected from the elements so that moderate rain conditions do not unduly impair the pilot's view of the flight path in normal flight and while landing.

(b) Each pilot compartment must have a means to either remove or prevent the formation of fog or frost on an area of the internal portion of the windshield and side windows sufficiently large to provide the view specified in paragraph (a)(1) of this section. Compliance must be shown under all expected external and internal ambient operating conditions, unless it can be shown that the windshield and side windows can be easily cleared by the pilot without interruption of normal pilot duties.

(Change 523-4 (96-09-01))

523.775 *Windshields and Windows*

(a) [The internal panels of windshields and windows must be constructed of a non-splintering material, such as non-splintering safety glass.]

(b) The design of windshields, windows, and canopies in pressurized aeroplanes must be based on factors peculiar to high altitude operation, including:

(1) The effects of continuous and cyclic pressurisation loadings;

(2) The inherent characteristics of the material used; and

(3) The effects of temperatures and temperature gradients.

(c) [On pressurized aeroplanes, if certification for operation up to and including 25,000 feet is requested, an enclosure canopy including a representative part of the installation must be subjected to special tests to account for the combined effects of continuous and cyclic pressurization loadings and flight loads, or compliance with the fail-safe requirements of paragraph (d) of this section must be shown.

[(d)] If certification for operation above 25,000 feet is requested, the windshields, window panels, and canopies must be strong enough to withstand the maximum cabin pressure differential loads combined with critical aerodynamic pressure and temperature effects, after failure of any load-carrying element of the windshield, window panel, or canopy.

(e) [The windshield and side windows forward of the pilot's back when the pilot is seated in the normal flight position must have a luminous transmittance value of not less than 70 percent.]

(f) Unless operation in known or forecast icing conditions is prohibited by operating limitations, a means must be provided to prevent or to clear accumulations of ice from the windshield so that the pilot has adequate view for taxi, takeoff, approach, landing, and to perform any manoeuvres within the operating limitations of the aeroplane.

(g) In the event of any probable single failure, a transparency heating system must be incapable of raising the temperature of any windshield or window to a point where there would be:

(1) structural failure that adversely affects the integrity of the cabin; or

(2) there would be a danger of fire.

[(h) In addition, for commuter category aeroplanes, the following applies:

[(1) Windshield panes directly in front of the pilots in the normal conduct of their duties, and the supporting structures for these panes, must withstand, without penetration, the impact of a two-pound bird when the velocity of the aeroplane (relative to the bird along the aeroplane's flight path) is equal to the aeroplane's maximum approach flap speed.

[(2) The windshield panels in front of the pilots must be arranged so that, assuming the loss of vision through any one panel, one or more panels remain available for use by a pilot seated at a pilot station to permit continued safe flight and landing.]

(Change 523-4 (96-09-01))
(Change 523-5)

523.777 *Cockpit Controls*

(a) Each cockpit control must be located and (except where its function is obvious) identified to provide convenient operation and to prevent confusion and inadvertent operation.

(b) The controls must be located and arranged so that the pilot, when seated, has full and unrestricted movement of each control without interference from either his clothing or the cockpit structure.

(c) Powerplant controls must be located:

(1) For multi-engine aeroplanes, on the pedestal or overhead at or near the centre of the cockpit;

(2) [For single and tandem seated single-engine aeroplanes, on the left side console or instrument panel;]

(3) For other single-engine aeroplanes at or near the centre of the cockpit, on the pedestal, instrument panel, or overhead; and

(4) For aeroplanes, with side-by- side pilot seats and with two sets of powerplant controls, on left and right consoles.

(d) The control location order from left to right must be power (thrust) lever, propeller (rpm control), and mixture control (condition lever and fuel cut-off for turbine-powered aeroplanes). Power (thrust) levers must be at least one inch higher or longer to make them more prominent than propeller (rpm control) or mixture controls. Carburettor heat or alternate air control must be to the left of the throttle or at least eight inches from the mixture control when located other than on a pedestal. Carburettor heat or alternate air control, when located on a pedestal must be aft or below the power (thrust) lever. Supercharger controls must be located below or aft of the propeller controls. Aeroplanes with tandem seating or single-place aeroplanes may utilize control locations on the left side of the cabin compartment; however, location order from left to right must be power (thrust) lever, propeller (rpm control) and mixture control.

(e) Identical powerplant controls for each engine must be located to prevent confusion as to the engines they control.

(1) Conventional multi-engine powerplant controls must be located so that the left control(s) operates the left engine(s) and the right control(s) operates the right engine(s).

(2) On twin-engine aeroplanes with front and rear engine locations (tandem), the left powerplant controls must operate the front engine and the right powerplant controls must operate the rear engine.

(f) Wing flap and auxiliary lift device controls must be located:

(1) Centrally, or to the right of the pedestal or powerplant throttle control centreline; and

(2) Far enough away from the landing gear control to avoid confusion.

(g) The landing gear control must be located to the left of the throttle centreline or pedestal centreline.

(h) Each fuel feed selector control must comply with 523.995 and be located and arranged so that the pilot can see and reach it without moving any seat or primary flight control when his seat is at any position in which it can be placed.

(1) For a mechanical fuel selector:

(i) The indication of the selected fuel valve position must be by means of a pointer and must provide positive identification and feel (detent, etc.) of the selected position.
(amended 2010/05/27)

(ii) The position indicator pointer must be located at the part of the handle that is the maximum dimension of the handle measured from the centre of rotation.

(2) For electrical or electronic fuel selector:

(i) Digital controls or electrical switches must be properly labelled.

(ii) Means must be provided to indicate to the flight crew the tank or function selected. Selector switch position is not acceptable as a means of indication. The "off" or "closed" position must be indicated in red.

(3) If the fuel valve selector handle or electrical or digital selection is also a fuel shut-off selector, the off position marking must be coloured red. If a separate emergency shut-off means is provided, it also must be coloured red.

(Change 523-1 (88-01-01))
(Change 523-5)

523.779 *Motion and Effect of Cockpit Controls*

Cockpit controls must be designed so that they operate in accordance with the following movement and actuation:

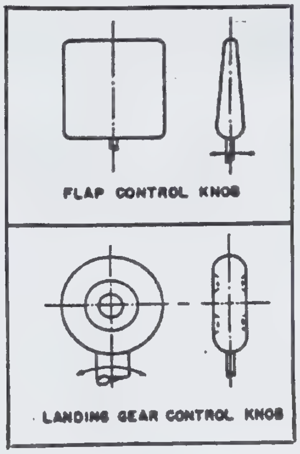
(a) Aerodynamic Controls:	*Motion And Effect*
(1) Primary controls	
Aileron	Right (clockwise) for right wing down.
Elevator	Rearward for nose up.
Rudder	Right pedal forward for nose right.
(2) Secondary controls:	
Flaps (or auxiliary lift devices)	Forward or up for flaps up or auxiliary device stowed; rearward or down for flaps down or auxiliary device deployed.
Trim tabs (or equivalent)	Switch motion or mechanical rotation of control to produce similar rotation of the aeroplane about an axis parallel to the axis control. Axis of roll trim control may be displaced to accommodate comfortable actuation by the pilot. For single-engine aeroplanes, direction of pilot's hand movement must be in the same sense as aeroplane response for rudder trim if only a rotational element is accessible.

(b) Powerplant And Auxiliary Controls:	*Motion And Effect*
(1) Powerplant controls:	
Power (thrust) lever	Forward to increase forward thrust and rearward to increase rearward thrust.
Propellers	Forward to increase rpm.
Mixture	Forward or upward for rich.
[Fuel]	[Forward for open]
Carburettor, air heat or alternate air	Forward or upward for cold.
Super-charger	Forward or upward for low blower.
Turbo-super-charger	Forward, upward, or clockwise to increase pressure.
Rotary controls	Clockwise from off to full on.
(2) Auxiliary controls:	
Fuel tank selector	Right for right tanks, left for left tanks.
Landing gear	Down to extend.
Speed brakes	Aft to extend.

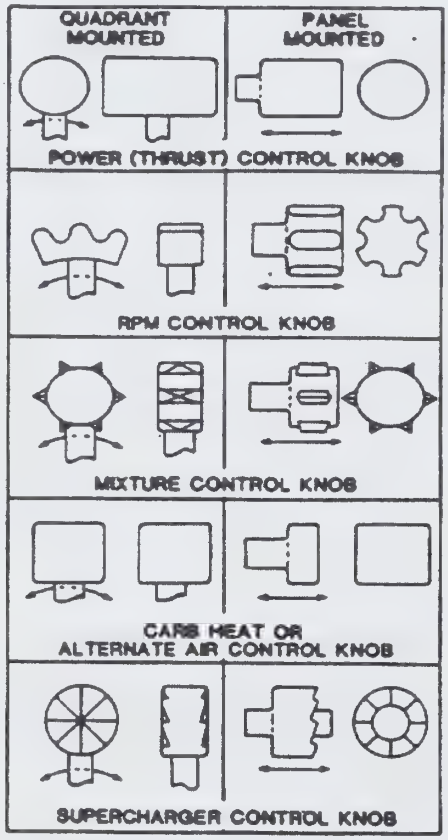
(Change 523-1 (88-01-01))
(Change 523-5)

523.781 *Cockpit Control Knob Shape*

(a) Flap and landing gear control knobs must conform to the general shapes (but not necessarily the exact sizes or specific proportions) in the following figure:



(b) Powerplant control knobs must conform to the general shapes (but not necessarily the exact sizes or specific proportions) in the following figure:



(Change 523-1 (88-01-01))

523.783 *Doors*

(a) Each closed cabin with passenger accommodations must have at least one adequate and easily accessible external door.

(b) [Passenger doors must not be located with respect to any propeller disk or any other potential hazard so as to endanger persons using the door.]

(c) Each external passenger or crew door must comply with the following requirements:

(1) There must be a means to lock and safeguard the door against inadvertent opening during flight by persons, by cargo, or as a result of mechanical failure.

(2) The door must be openable from the inside and the outside when the internal locking mechanism is in the locked position.

(3) There must be a means of opening which is simple and obvious and is arranged and marked inside and outside so that the door can be readily located, unlocked, and opened, even in darkness.

(4) The door must meet the marking requirements of 523.811 of this Chapter.

(5) The door must be reasonably free from jamming as a result of fuselage deformation in an emergency landing.

(6) Auxiliary locking devices that are actuated externally to the aeroplane may be used but such devices must be overridden by the normal internal opening means.

(d) In addition, each external passenger or crew door, for a commuter category aeroplane, must comply with the following requirements:

(1) Each door must be openable from both the inside and outside, even though persons may be crowded against the door on the inside of the aeroplane.

(2) If inward opening doors are used, there must be a means to prevent occupants from crowding against the door to the extent that would interfere with opening the door.

(3) Auxiliary locking devices may be used.

(e) Each external door on a commuter category aeroplane, each external door forward of any engine or propeller on a normal, utility, or aerobatic category aeroplane, and each door of the pressure vessel on a pressurised aeroplane must comply with the following requirements:

(1) There must be a means to lock and safeguard each external door, including cargo and service type doors, against inadvertent opening in flight, by persons, by cargo, or as a result of mechanical failure or failure of a single structural element, either during or after closure.

(2) There must be a provision for direct visual inspection of the locking mechanism to determine if the external door, for which the initial opening movement is not inward, is fully closed and locked. The provisions must be discernible, under operating lighting conditions, by a crewmember using a flashlight or an equivalent lighting source.

(3) There must be a visual warning means to signal a flight crew member if the external door is not fully closed and locked. The means must be designed so that any failure, or combination of failures, that would result in an erroneous closed and locked indication is improbable for doors for which the initial opening movement is not inward.

[(f) In addition, for commuter category aeroplanes, the following requirements apply:

[(1) Each passenger entry door must qualify as a floor level emergency exit. This exit must have a rectangular opening of not less than 24 inches wide by 48 inches high, with corner radii not greater than one-third the width of the exit.

[(2) If an integral stair is installed at a passenger entry door, the stair must be designed so that, when subjected to the inertia loads resulting from the ultimate static load factors in 523.561(b)(2) and following the collapse of one or more legs of the landing gear, it will not reduce the effectiveness of emergency egress through the passenger entry door.

[(g) If lavatory doors are installed, they must be designed to preclude an occupant from becoming trapped inside the lavatory. If a locking mechanism is installed, it must be capable of being unlocked from outside of the lavatory.]

(Change 523-1 (88-01-01))
(Change 523-2 (89-01-01))
(Change 523-5)

523.785 *Seats, Berths, Litters, Safety Belts, and Shoulder Harnesses*

[There must be a seat or berth for each occupant that meets the following:]

(a) Each seat/restraint system and the supporting structure must be designed to support occupants weighing at least 215 pounds when subjected to the maximum load factors corresponding to the specified flight and ground load conditions, as defined in the approved operating envelope of the aeroplane. In addition, these loads must be multiplied by a factor of 1.33 in determining the strength of all fittings and the attachment of:

(1) Each seat to the structure; and

(2) Each safety belt and shoulder harness to the seat or structure.

(b) [Each forward-facing or aft-facing seat/restraint system in normal, utility, or aerobatic category aeroplanes must consist of a seat, a safety belt, and a shoulder harness, with a metal-to-metal latching device, that are designed to provide the occupant protection provisions required in 523.562. Other seat orientations must provide the same level of occupant protection as a forward-facing or aft-facing seat with a safety belt and a shoulder harness, and must provide the protection provisions of 523.562

(c) [For commuter category aeroplanes, each seat and the supporting structure must be designed for occupants weighing at least 170 pounds when subjected to the inertia loads resulting from the ultimate static load factors prescribed in 523.561(b)(2) of this Chapter. Each occupant must be protected from serious head injury when subjected to the inertia loads resulting from these load factors by a safety belt and shoulder harness, with a metal-to-metal latching device, for the front seats and a safety belt, or a safety belt and shoulder harness, with a metal-to-metal latching device, for each seat other than the front seats.]

(d) Each restraint system must have a single-point release for occupant evacuation.

(e) The restraint system for each crew member must allow the crew member, when seated with the safety belt and shoulder harness fastened, to perform all functions necessary for flight operations.

(f) Each pilot seat must be designed for the reactions resulting from the application of pilot forces to the primary flight controls as prescribed in 523.395 of this Chapter.

(g) There must be a means to secure each safety belt and shoulder harness, when not in use, to prevent interference with the operation of the aeroplane and with rapid occupant egress in an emergency.

(h) Unless otherwise placarded, each seat in a utility or aerobatic category aeroplane must be designed to accommodate an occupant wearing a parachute.

(i) The cabin area surrounding each seat, including the structure, interior walls, instrument panel, control wheel, pedals, and seats within striking distance of the occupant's head or torso (with the restraint system fastened) must be free of potentially injurious objects, sharp edges, protuberances, and hard surfaces. If energy absorbing designs or devices are used to meet this requirement, they must protect the occupant from serious injury when the occupant is subjected to the inertia loads resulting from the ultimate static load factors prescribed in 523.561(b)(2) of this Chapter, or they must comply with the occupant protection provisions of 523.562 of this Chapter, as required in paragraphs (b) and (c) of this section.

(j) Each seat track must be fitted with stops to prevent the seat from sliding off the track.

(k) Each seat/restraint system may use design features, such as crushing or separation of certain components, to reduce occupant loads when showing compliance with the requirements of 523.562 of this Chapter; otherwise, the system must remain intact.

(l) For the purposes of this section, a front seat is a seat located at a flight crew member station or any seat located along-side such a seat.

(m) Each berth, or provisions for a litter, installed parallel to the longitudinal axis of the aeroplane, must be designed so that the forward part has a padded end-board, canvas diaphragm, or equivalent means that can withstand the load reactions from a 215-pound occupant when subjected to the inertia loads resulting from the ultimate static load factors of 523.561(b)(3) of this Chapter. In addition:

(1) Each berth or litter must have an occupant restraint system and may not have corners or other parts likely to cause serious injury to a person occupying it during emergency landing conditions; and

(2) Occupant restraint system attachments for the berth or litter must withstand the inertia loads resulting from the ultimate static load factors of 523.561(b)(3) of this Chapter.

(n) Proof of compliance with the static strength requirements of this section for seats and berths approved as part of the type design and for seat and berth installations may be shown by:

(1) Structural analysis, if the structure conforms to conventional aeroplane types for which existing methods of analysis are known to be reliable;

(2) A combination of structural analysis and static load tests to limit load; or

(3) Static load tests to ultimate loads.

(Change 523-1 (88-01-01))
(Change 523-2 (89-01-01))
(Change 523-5)

523.787 *[Baggage and Cargo Compartments*

(a) [Each baggage and cargo compartment must:

[(1) Be designed for its placarded maximum weight of contents and for the critical load distributions at the appropriate maximum load factors corresponding to the flight and ground load conditions of this Chapter.

[(2) Have means to prevent the contents of any compartment from becoming a hazard by shifting, and to protect any controls, wiring, lines, equipment or accessories whose damage or failure would affect safe operations.

[(3) Have a means to protect occupants from injury by the contents of any compartment, located aft of the occupants and separated by structure, when the ultimate forward inertial load factor is 9g and assuming the maximum allowed baggage or cargo weight for the compartment.

(b) [Designs that provide for baggage or cargo to be carried in the same compartment as passengers must have a means to protect the occupants from injury when the baggage or cargo is subjected to the inertial loads resulting from the ultimate static load factors of 523.561(b)(3), assuming the maximum allowed baggage or cargo weight for the compartment.

(c) [For aeroplanes that are used only for the carriage of cargo, the flight crew emergency exits must meet the requirements of 523.807 under any cargo loading conditions.]

(Change 523-1 (88-01-01))
(Change 523-2 (89-01-01))
(Change 523-5)

[523.791 *Passenger Information Signs*

[For those aeroplanes in which the flight crew members cannot observe the other occupants' seats or where the flight crew members' compartment is separated from the passenger compartment, there must be at least one illuminated sign (using either letters or symbols) notifying all passengers when seat belts should be fastened. Signs that notify when seat belts should be fastened must:

[(a) When illuminated, be legible to each person seated in the passenger compartment under all probable lighting conditions; and

[(b) Be installed so that a flight crew member can, when seated at the flight crew member's station, turn the illumination on and off.]

(Change 523-5)

523.803 *Emergency Evacuation*

[(a)] For commuter category aeroplanes, an evacuation demonstration must be conducted utilizing the maximum number of occupants for which certification is desired. The demonstration must be conducted under simulated night conditions using only the emergency exits on the most critical side of the aeroplane. The participants must be representative of average airline passengers with no prior practice or rehearsal for the demonstration. Evacuation must be completed within 90 seconds.

[(b) In addition, when certification to the emergency exit provisions of 523.807(d)(4) is requested, only the emergency lighting system required by 523.812 may be used to provide cabin interior illumination during the evacuation demonstration required in paragraph (a) of this section.]

(Change 523-1 (88-01-01))
(Change 523-5)

[523.805 *Flight Crew Emergency Exits*

[For aeroplanes where the proximity of the passenger emergency exits to the flight crew area does not offer a convenient and readily accessible means of evacuation for the flight crew, the following apply:

[(a) There must be either one emergency exit on each side of the aeroplane, or a top hatch emergency exit, in the flight crew area;

[(b) Each emergency exit must be located to allow rapid evacuation of the crew and have a size and shape of at least a 19- by 20-inch unobstructed rectangular opening; and

[(c) For each emergency exit that is not less than six feet from the ground, an assisting means must be provided. The assisting means may be a rope or any other means demonstrated to be suitable for the purpose. If the assisting means is a rope, or an approved device equivalent to a rope, it must be:

[(1) Attached to the fuselage structure at or above the top of the emergency exit opening or, for a device at a pilot's emergency exit window, at another approved location if the stowed device, or its attachment, would reduce the pilot's view; and

[(2) Able (with its attachment) to withstand a 400-pound static load.]

(Change 523-5)

523.807 *Emergency Exits*

(a) *Number and location.* Emergency exits must be located to allow escape without crowding in any probable crash attitude. The aeroplane must have at least the following emergency exits:

(1) For all aeroplanes, with a seating capacity of two or more, excluding aeroplanes with canopies, at least one emergency exit on the opposite side of the cabin from the main door specified in 523.783 of this Chapter.

(2) (Reserved)

(3) If the pilot compartment is separated from the cabin by a door that is likely to block the pilot's escape in a minor crash, there must be an exit in the pilot's compartment. The number of exits required by subparagraph (1) of this paragraph must then be separately determined for the passenger compartment, using the seating capacity of that compartment.

[(4) Emergency exits must not be located with respect to any propeller disk or any other potential hazard so as to endanger persons using that exit.

(b) [*Type and operation*. Emergency exits must be movable windows, panels, canopies, or external doors, openable from both inside and outside the aeroplane, that provide a clear and unobstructed opening large enough to admit a 19-by-26-inch ellipse. Auxiliary locking devices used to secure the aeroplane must be designed to be overridden by the normal internal opening means. The inside handles of emergency exits that open outward must be adequately protected against inadvertent operation. In addition, each emergency exit must:]

(1) Be readily accessible, requiring no exceptional agility to be used in emergencies;

(2) Have a method of opening that is simple and obvious;

(3) Be arranged and marked for easy location and operation, even in darkness;

(4) Have reasonable provisions against jamming by fuselage deformation; and

(5) [In the case of aerobatic category aeroplanes, allow each occupant to abandon the aeroplane at any speed between V_{SO} and V_D; and

[(6) In the case of utility category aeroplanes certificated for spinning, allow each occupant to abandon the aeroplane at the highest speed likely to be achieved in the manoeuvre for which the aeroplane is certificated.]

(c) *Tests*. The proper functioning of each emergency exit must be shown by tests.

(d) [*Doors and exits*. In addition, for commuter category aeroplanes the following requirements apply:

(1) [In addition to the passenger-entry door

(i) [For an aeroplane with a total passenger seating capacity of 15 or fewer, an emergency exit, as defined in paragraph (b) of this section, is required on each side of the cabin; and

(ii) [For an aeroplane with a total passenger seating capacity of 16 through 19, three emergency exits, as defined in paragraph (b) of this section, are required with one on the same side as the passenger entry door and two on the side opposite the door.]

(2) A means must be provided to lock each emergency exit and to safeguard against its opening in flight, either inadvertently by persons or as a result of mechanical failure. In addition, a means for direct visual inspection of the locking mechanism must be provided to determine that each emergency exit for which the initial opening movement is outward is fully locked.

(3) [Each required emergency exit, except floor level exits, must be located over the wing or, if not less than six feet from the ground, must be provided with an acceptable means to assist the occupants to descend to the ground. Emergency exits must be distributed as uniformly as practical, taking into account passenger seating configuration.

(4) [Unless the applicant has complied with paragraph (d)(1) of this section, there must be an emergency exit on the side of the cabin opposite the passenger entry door, provided that:

[(i) For an aeroplane having a passenger seating configuration of nine or fewer, the emergency exit has a rectangular opening measuring not less than 19 inches by 26 inches high with corner radii not greater than one-third the width of the exit, located over the wing, with a step up inside the aeroplane of not more than 29 inches and a step down outside the aeroplane of not more than 36 inches;

[(ii) For an aeroplane having a passenger seating configuration of 10 to 19 passengers, the emergency exit has a rectangular opening measuring not less than 20 inches wide by 36 inches high, with corner radii not greater than one-third the width of the exit, and with a step up inside the aeroplane of not more than 20 inches. If the exit is located over the wing, the step down outside the aeroplane may not exceed 27 inches; and

[(iii) The aeroplane complies with the additional requirements of 523.561(b)(2)(iv), 523.803(b), 523.811(c), 523.812, 523.813(b), and 523.815.

[(e) For multi-engine aeroplanes, ditching emergency exits must be provided in accordance with the following requirements, unless the emergency exits required by paragraph (a) or (d) of this section already comply with them:

[(1) One exit above the waterline on each side of the aeroplane having the dimensions specified in paragraph (b) or (d) of this section, as applicable; and

[(2) If side exits cannot be above the waterline; there must be a readily accessible overhead hatch emergency exit that has a rectangular opening measuring not less than 20 inches wide by 36 inches long, with corner radii not greater than one-third the width of the exit.]

(Change 523-1 (88-01-01))
(Change 523-2 (89-01-01))
(Change 523-5)

523.811 *Emergency Exit Marking*

(a) Each emergency exit and external door in the passenger compartment must be externally marked and readily identifiable from outside the aeroplane by:

(1) A conspicuous visual identification scheme; and

(2) A permanent decal or placard on or adjacent to the emergency exit which shows the means of opening the emergency exit, including any special instructions, if applicable.

(b) In addition, for commuter category aeroplanes, these exits and doors must be internally marked with the word "exit" by a sign which has white letters 1 inch high on a red background 2 inches high, be self-illuminated or independently, internally electrically illuminated, and have a minimum brightness of at least 160 microlamberts. The colour may be reversed if the passenger compartment illumination is essentially the same.

[(c) In addition, when certification to the emergency exit provisions of 523.807(d)(4) is requested, the following apply:

[(1) Each emergency exit, its means of access, and its means of opening, must be conspicuously marked;

[(2) The identity and location of each emergency exit must be recognizable from a distance equal to the width of the cabin;

[(3) Means must be provided to assist occupants in locating the emergency exits in conditions of dense smoke;

[(4) The location of the operating handle and instructions for opening each emergency exit from inside the aeroplane must be shown by marking that is readable from a distance of 30 inches;

[(5) Each passenger entry door operating handle must:

[(i) Be self-illuminated with an initial brightness of at least 160 microlamberts; or

[(ii) Be conspicuously located and well illuminated by the emergency lighting even in conditions of occupant crowding at the door;

[(6) Each passenger entry door with a locking mechanism that is released by rotary motion of the handle must be marked:

[(i) With a red arrow, with a shaft of at least three-fourths of an inch wide and a head twice the width of the shaft, extending along at least 70 degrees of arc at a radius approximately equal to three-fourths of the handle length;

[(ii) So that the centre line of the exit handle is within (one inch of the projected point of the arrow when the handle has reached full travel and has released the locking mechanism;

[(iii) With the word "open" in red letters, one inch high, placed horizontally near the head of the arrow; and

[(7) In addition to the requirements of paragraph (a) of this section, the external marking of each emergency exit must:

[(i) Include a 2-inch colour band outlining the exit; and

[(ii) Have a colour contrast that is readily distinguishable from the surrounding fuselage surface. The contrast must be such that if the reflectance of the darker colour is 15 percent or less, the reflectance of the lighter colour must be at least 45 percent. "Reflectance" is the ratio of the luminous flux reflected by a body to the luminous flux it receives. When the reflectance of the darker colour is greater than 15 percent, at least 30 percent difference between its reflectance and the reflectance of the lighter colour must be provided.]

(Change 523-2 (89-01-01))
(Change 523-5)

[523.812 *Emergency Lighting*

[When certification to the emergency exit provisions of 523.807(d)(4) is requested, the following apply:

[(a) An emergency lighting system, independent of the main cabin lighting system, must be installed. However, the source of general cabin illumination may be common to both the emergency and main lighting systems if the power supply to the emergency lighting system is independent of the power supply to the main lighting system.

[(b) There must be a crew warning light that illuminates in the cockpit when power is on in the aeroplane and the emergency lighting control device is not armed.

[(c) The emergency lights must be operable manually from the flight crew station and be provided with automatic activation. The cockpit control device must have "on," "off," and "armed" positions so that, when armed in the cockpit, the lights will operate by automatic activation.

[(d) There must be a means to safeguard against inadvertent operation of the cockpit control device from the "armed" or "on" positions.

[(e) The cockpit control device must have provisions to allow the emergency lighting system to be armed or activated at any time that it may be needed.

[(f) When armed, the emergency lighting system, must activate and remain lighted when:

[(1) The normal electrical power of the aeroplane is lost; or

[(2) The aeroplane is subjected to an impact that results in a deceleration in excess of 2g and a velocity change in excess of 3.5 feet-per-second, acting along the longitudinal axis of the aeroplane; or

[(3) Any other emergency condition exists where automatic activation of the emergency lighting is necessary to aid with occupant evacuation.

[(g) The emergency lighting system must be capable of being turned off and reset by the flight crew after automatic activation.

[(h) The emergency lighting system must provide internal lighting, including:

[(1) Illuminated emergency exit marking and locating signs including those required in 523.811(b);

[(2) Sources of general illumination in the cabin that provide an average illumination of not less than 0.05 foot-candle and an illumination at any point of not less than 0.01 foot-candle when measured along the centre line of the main passenger aisle(s) and at the seat armrest height; and

[(3) Floor proximity emergency escape path marking that provides emergency evacuation guidance for the aeroplane occupants when all sources of illumination more than 4 feet above the cabin aisle floor are totally obscured.

[(i) The energy supply to each emergency lighting unit must provide the required level of illumination for at least 10 minutes at the critical ambient conditions after activation of the emergency lighting system.

[(j) If rechargeable batteries are used as the energy supply for the emergency lighting system, they may be recharged from the main electrical power system of the aeroplane provided the charging circuit is designed to preclude inadvertent battery discharge into the charging circuit faults. If the emergency lighting system does not include a charging circuit, battery condition monitors are required.

[(k) Components of the emergency lighting system, including batteries, wiring, relays, lamps, and switches, must be capable of normal operation after being subjected to the inertia forces resulting from the ultimate load factors prescribed in 523.561(b)(2).

[(l) The emergency lighting system must be designed so that after any single transverse vertical separation of the fuselage during a crash landing:

[(1) At least 75 percent of all electrically illuminated emergency lights required by this section remain operative; and

[(2) Each electrically illuminated exit sign required by 523.811(b) and (c) remains operative, except those that are directly damaged by the fuselage separation.]

(Change 523-5)

523.813 *Emergency Exit Access*

[(a)] For commuter category aeroplanes, access to window-type emergency exits may not be obstructed by seats or seat backs.

[(b) In addition, when certification to the emergency exit provisions of 523.807(d)(4) is requested, the following emergency exit access must be provided:

[(1) The passageway leading from the aisle to the passenger entry door must be unobstructed and at least 20 inches wide.

[(2) There must be enough space next to the passenger entry door to allow assistance in evacuation of passengers without reducing the unobstructed width of the passageway below 20 inches.

[(3) If it is necessary to pass through a passageway between passenger compartments to reach a required emergency exit from any seat in the passenger cabin, the passageway must be unobstructed; however, curtains may be used if they allow free entry through the passageway.

[(4) No door may be installed in any partition between passenger compartments unless that door has a means to latch it in the open position. The latching means must be able to withstand the loads imposed upon it by the door when the door is subjected to the inertia loads resulting from the ultimate static load factors prescribed in 523.561(b)(2).

[(5) If it is necessary to pass through a doorway separating the passenger cabin from other areas to reach a required emergency exit from any passenger seat, the door must have a means to latch it in the open position. The latching means must be able to withstand the loads imposed upon it by the door when the door is subjected to the inertia loads resulting from the ultimate static load factors prescribed in 523.561(b)(2).]

(Change 523-2 (89-01-01))
(Change 523-5)

523.815 *Width of Aisle*

[(a)] Except as provided in paragraph (b) of this section, for commuter category aeroplanes, the width of the main passenger aisle at any point between seats must equal or exceed the values in Table below:

Number Of Passenger Seats	*Minimum Main Passenger Aisle Width*	
	Less than 25 inches from floor	25 inches and more from floor
10 through 19	9 inches	15 inches

[(b) When certification to the emergency exit provisions of 523.807(d)(4) is requested, the main passenger aisle width at any point between the seats must equal or exceed the following values:]

Number Of Passenger Seats	*Minimum Main Passenger Aisle Width (Inches)*	
	Less than 25 inches from floor	25 inches and more from floor
[10 or fewer	[[1] 12	[15
11 through 19	12	20
[[1] A narrower width not less than 9 inches may be approved when substantiated by tests found necessary by the Minister.]		

(Change 523-1 (88-01-01))
(Change 523-5)

523.831 *Ventilation*

(a) Each passenger and crew compartment must be suitably ventilated. Carbon monoxide concentration may not exceed one part in 20,000 parts of air.

(b) For pressurised aeroplanes, the ventilating air in the flight crew and passenger compartments must be free of harmful or hazardous concentrations of gases and vapours in normal operations and in the event of reasonably probable failures or malfunctioning of the ventilating, heating, pressurization, or other systems and equipment. If accumulation of hazardous quantities of smoke in the cockpit area is reasonably probable, smoke evacuation must be readily accomplished starting with full pressurization and without depressurizing beyond safe limits.

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))

Pressurization

523.841 *Pressurized Cabins*

(a) [If certification for operation over 25,000 feet is requested, the aeroplane must be able to maintain a cabin pressure altitude of not more than 15,000 feet in event of any probable failure or malfunction in the pressurization system.]

(b) Pressurized cabins must have at least the following valves, controls, and indicators, for controlling cabin pressure:

(1) Two pressure relief valves to automatically limit the positive pressure differential to a predetermined value at the maximum rate of flow delivered by the pressure source. The combined capacity of the relief valves must be large enough so that the failure of any one valve would not cause an appreciable rise in the pressure differential. The pressure differential is positive when the internal pressure is greater than the external.

(2) Two reverse pressure differential relief valves (or their equivalent) to automatically prevent a negative pressure differential that would damage the structure. However, one valve is enough if it is of a design that reasonably precludes its malfunctioning.

(3) A means by which the pressure differential can be rapidly equalized.

(4) An automatic or manual regulator for controlling the intake or exhaust airflow, or both, for maintaining the required internal pressures and airflow rates.

(5) Instruments to indicate to the pilot the pressure differential, the cabin pressure altitude, and the rate of change of cabin pressure altitude.

(6) Warning indication at the pilot station to indicate when the safe or pre-set pressure differential is exceeded and when a cabin pressure altitude of 10,000 feet is exceeded.

(7) A warning placard for the pilot if the structure is not designed for pressure differentials up to the maximum relief valve setting in combination with landing loads.

(8) A means to stop rotation of the compressor or to divert airflow from the cabin if continued rotation of an engine-driven cabin compressor or continued flow of any compressor bleed air will create a hazard if a malfunction occurs.

(Change 523-5)

523.843 *Pressurization Tests*

(a) *Strength test.* The complete pressurized cabin, including doors, windows, canopy, and valves, must be tested as a pressure vessel for the pressure differential specified in 523.365(d).

(b) *Functional tests.* The following functional tests must be performed:

(1) Tests of the functioning and capacity of the positive and negative pressure differential valves, and of the emergency release valve, to simulate the effects of closed regulator valves.

(2) Tests of the pressurization system to show proper functioning under each possible condition of pressure, temperature, and moisture, up to the maximum altitude for which certification is requested.

(3) Flight tests, to show the performance of the pressure supply, pressure and flow regulators, indicators, and warning signals, in steady and stepped climbs and descents at rates corresponding to the maximum attainable within the operating limitations of the aeroplane, up to the maximum altitude for which certification is requested.

(4) Tests of each door and emergency exit, to show that they operate properly after being subjected to the flight tests prescribed in subparagraph (3) of this paragraph.

Fire Protection

523.851 *Fire Extinguishers*

(a) There must be at least one hand fire extinguisher for use in the pilot compartment that is located within easy access of the pilot while seated.

(b) There must be at least one hand fire extinguisher located conveniently in the passenger compartment:

(1) Of each aeroplane accommodating more than 6 passengers; and

(2) Of each commuter category aeroplane.

(c) For hand fire extinguishers, the following apply:

(1) The type and quantity of each extinguishing agent used must be appropriate to the kinds of fire likely to occur where that agent is to be used.

(2) Each extinguisher for use in a personnel compartment must be designed to minimize the hazard of toxic gas concentrations.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))

523.853 *[Passenger and Crew Compartment Interiors]*

For each compartment to be used by the crew or passengers:

(a) The materials must be at least flame-resistant;

(b) (Reserved)

(c) If smoking is to be prohibited, there must be a placard so stating, and if smoking is to be allowed:

(1) There must be an adequate number of self-contained, removable ashtrays; and

(2) Where the crew compartment is separated from the passenger compartment, there must be at least one illustrated sign (using either letters or symbols) notifying all passengers when smoking is prohibited. Signs, which notify when smoking is prohibited, must:

(i) When illuminated, be legible to each passenger seated in the passenger cabin under all probable lighting conditions; and

(ii) Be so constructed that the crew can turn the illumination on and off.

(d) In addition, for commuter category aeroplanes the following requirements apply:

(1) Each disposal receptacle for towels, paper, or waste must be fully enclosed and constructed of at least fire resistant materials and must contain fires likely to occur in it under normal use. The ability of the disposal receptacle to contain those fires under all probable conditions of wear, misalignment, and ventilation expected in service must be demonstrated by test. A placard containing the legible words "No Cigarette Disposal" must be located on or near each disposal receptacle door.

(2) Lavatories must have "No Smoking" or "No Smoking in Lavatory" placards located conspicuously on each side of the entry door and self-contained, removable ashtrays located conspicuously on or near the entry side of each lavatory door, except that one ashtray may serve more than one lavatory door if it can be seen from the cabin side of each lavatory door served. The placards must have red letters and at least 1/2 inch high on a white background at least 1 inch high (a "No Smoking" symbol may be included on the placard).

(3) Materials (including finishes or decorative surfaces applied to the materials) used in each compartment occupied by the crew or passengers must meet the following test criteria as applicable:

(i) Interior ceiling panels, interior wall panels, partitions, galley structure, large cabinet walls, structural flooring, and materials used in the construction of stowage compartments for stowing small items such as magazines and maps) must be self-extinguishing when tested vertically in accordance with the applicable portions of Appendix F of this Chapter or by other equivalent methods. The average burn length may not exceed 6 inches and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 3 seconds after falling.

(ii) Floor covering, textiles (including draperies and upholstery), seat cushions, padding, decorative and non-decorative coated fabrics, leather trays and galley furnishings, electrical conduit, thermal and acoustical insulation and insulation covering, air ducting, joint and edge covering, cargo compartment liners, insulation blankets, cargo covers and transparencies, moulded and thermoformed parts, air ducting joints, and trim strips (decorative and chafing), that are constructed of materials not covered in paragraph (d)(3)(iv) of this section must be self extinguishing when tested vertically in accordance with the applicable portions of Appendix F of this Chapter or other approved equivalent methods. The average burn length may not exceed 8 inches and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 5 seconds after falling.

(iii) Motion picture film must be safety film meeting the Standard Specifications for Safety Photographic Film PH1.25 (available from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018) or an equivalent approved by the Minister. If the film travels through ducts, the ducts must meet the requirements of paragraph (d)(3)(ii) of this section.

(iv) Acrylic windows and signs, parts constructed in whole or in part of elastomeric materials, edge-lighted instrument assemblies consisting of two or more instruments in a common housing, seat belts, shoulder harnesses, and cargo and baggage tie-down equipment, including containers, bins, pallets, etc., used in passenger or crew compartments, may not have an average burn rate greater than 2.5 inches per minute when tested horizontally in accordance with the applicable portions of Appendix F of this Chapter or by other approved equivalent methods.

(v) Except for electrical wire cable insulation, and for small parts (such as knobs, handles, rollers, fasteners, clips, grommets, rub strips, pulleys, and small electrical parts) that the Minister finds would not contribute significantly to the propagation of a fire, materials in items not specified in (d)(3)(i), (ii), (iii) or (iv) of this section may not have a burn rate greater than 4.0 inches per minute when tested horizontally in accordance with the applicable portions of Appendix F of this Chapter or by other approved equivalent methods.

(e) Lines, tanks, or equipment containing fuel, oil, or other flammable fluids may not be installed in such compartments unless adequately shielded, isolated, or otherwise protected so that any breakage or failure of such an item would not create a hazard.

(f) Aeroplane materials located on the cabin side of the firewall must be self-extinguishing or be located at such a distance from the firewall, or otherwise protected, so that ignition will not occur if the firewall is subjected to a flame temperature of not less than 2,000 degrees F for 15 minutes. For self-extinguishing materials (except electrical wire and cable insulation and small parts that the Minister finds would not contribute significantly to the propagation of a fire), a vertical self-extinguishing test must be conducted in accordance with Appendix F of this Chapter or an equivalent method approved by the Minister. The average burn length of the material may not exceed 6 inches and the average flame time after removal of the flame source may not exceed 15 seconds.

Drippings from the material test specimen may not continue to flame for more than an average of 3 seconds after falling.

(Change 523-1 (88-01-01))
(Change 523-5)

[523.855 *Cargo and Baggage Compartment Fire Protection*

[(a) Sources of heat within each cargo and baggage compartment that are capable of igniting the compartment contents must be shielded and insulated to prevent such ignition.

[(b) Each cargo and baggage compartment must be constructed of materials that meet the appropriate provisions of 523.853(d)(3).

[(c) In addition, for commuter category aeroplanes, each cargo and baggage compartment must:

[(1) Be located where the presence of a fire would be easily discovered by the pilots when seated at their duty station, or it must be equipped with a smoke or fire detector system to give a warning at the pilots' station, and provide sufficient access to enable a pilot to effectively reach any part of the compartment with the contents of a hand held fire extinguisher, or

[(2) Be equipped with a smoke or fire detector system to give a warning at the pilots' station and have ceiling and sidewall liners and floor panels constructed of materials that have been subjected to and meet the 45 degree angle test of Appendix F of this Chapter. The flame may not penetrate (pass through) the material during application of the flame or subsequent to its removal. The average flame time after removal of the flame source may not exceed 15 seconds, and the average glow time may not exceed 10 seconds. The compartment must be constructed to provide fire protection that is not less than that required of its individual panels; or

[(3) Be constructed and sealed to contain any fire within the compartment.]

(Change 523-5)

523.859 *Combustion Heater Fire Protection*

(a) *Combustion heater fire regions.* The following combustion heater fire regions must be protected from fire in accordance with the applicable provisions of 523.1182 through 523.1191 and 523.1203:

(1) The region surrounding the heater, if this region contains any flammable fluid system components (excluding the heater fuel system) that could:

(i) Be damaged by heater malfunctioning; or

(ii) Allow flammable fluids or vapours to reach the heater in case of leakage.

(2) The region surrounding the heater, if the heater fuel system has fittings that, if they leaked, would allow fuel vapour to enter this region.

(3) The part of the ventilating air passage that surrounds the combustion chamber.

(b) *Ventilating air ducts.* Each ventilating air duct passage through any fire region must be fireproof. In addition:

(1) Unless isolation is provided by fireproof valves or by equally effective means, the ventilating air duct downstream of each heater must be fireproof for a distance great enough to ensure than any fire originating in the heater can be contained in the duct; and

(2) Each part of any ventilating duct passing through any region having a flammable fluid system must be constructed or isolated from that system so that the malfunctioning of any component of that system cannot introduce flammable fluids or vapours into the ventilating airstream.

(c) *Combustion air ducts.* Each combustion air duct must be fireproof for a distance great enough to prevent damage from backfiring or reverse flame propagation. In addition:

(1) No combustion air duct may have a common opening with the ventilating airstream unless flames from backfires or reverse burning cannot enter the ventilating airstream under any operating condition, including reverse flow or malfunctioning of the heater or its associated components; and

(2) No combustion air duct may restrict the prompt relief of any backfire that, if so restricted, could cause heater failure.

(d) *Heater controls: General.* Provision must be made to prevent the hazardous accumulation of water or ice on or in any heater control component, control system tubing, or safety control.

(e) *Heater safety controls.*

(1) Each combustion heater must have the following safety controls:

(i) Means independent of the components for the normal continuous control of air temperature, airflow, and fuel flow must be provided to automatically shut off the ignition and fuel supply to that heater at a point remote from that heater when any of the following occurs:

(A) The heat exchanger temperature exceeds safe limits.

(B) The ventilating air temperature exceeds safe limits.

(C) The combustion airflow becomes inadequate for safe operation.

(D) The ventilating airflow becomes inadequate for safe operation.

(ii) Means to warn the crew when any heater whose heat output is essential for safe operation has been shut off by the automatic means prescribed in subparagraph (i) of this paragraph.

(2) The means for complying with subparagraph (1)(i) of this paragraph for any individual heater must:

(i) Be independent of components serving any other heater whose heat output is essential for safe operations; and

(ii) Keep the heater off until restarted by the crew.

(f) *Air intakes.* Each combustion and ventilating air intake must be located so that no flammable fluids or vapours can enter the heater system under any operating condition:

(1) During normal operation; or

(2) As a result of the malfunctioning of any other component.

(g) *Heater exhaust.* Heater exhaust systems must meet the provisions of 523.1121 and 523.1123. In addition, there must be provisions in the design of the heater exhaust system to safely expel the products of combustion to prevent the occurrence of:

(1) Fuel leakage from the exhaust to surrounding compartments;

(2) Exhaust gas impingement on surrounding equipment or structure;

(3) Ignition of flammable fluids by the exhaust, if the exhaust is in a compartment containing flammable fluid lines; and

(4) Restrictions in the exhaust system to relieve backfires that, if so restricted, could cause heater failure.

(h) *Heater fuel systems.* Each heater fuel system must meet each powerplant fuel system requirement affecting safe heater operation. Each heater fuel system component within the ventilating airstream must be protected by shrouds so that no leakage from those components can enter the ventilating airstream.

(i) *Drains.* There must be means to safely drain fuel that might accumulate within the combustion chamber or the heater exchanger. In addition:

(1) Each part of any drain that operates at high temperatures must be protected in the same manner as heater exhausts; and

(2) Each drain must be protected from hazardous ice accumulation under any operating condition.

523.863 *Flammable Fluid Fire Protection*

(a) In each area where flammable fluids or vapours might escape by leakage of a fluid system, there must be means to minimize the probability of ignition of the fluids and vapours, and the resultant hazard if ignition does occur.

(b) Compliance with paragraph (a) of this section must be shown by analysis or tests, and the following factors must be considered:

(1) Possible sources and paths of fluid leakage, and means of detecting leakage.

(2) Flammability characteristics of fluids, including effects of any combustible or absorbing materials.

(3) Possible ignition sources, including electrical faults, overheating of equipment, and malfunctioning of protective devices.

(4) Means available for controlling or extinguishing a fire, such as stopping flow of fluids, shutting down equipment, fireproof containment, or use of extinguishing agents.

(5) Ability of aeroplane components that are critical to safety of flight to withstand fire and heat.

(c) If action by the flight crew is required to prevent or counteract a fluid fire (e.g. equipment shutdown or actuation of a fire extinguisher), quick acting means must be provided to alert the crew.

(d) Each area where flammable fluids or vapours might escape by leakage of a fluid system must be identified and defined.

523.865 *Fire Protection of Flight Controls, Engine Mounts and Other Flight Structure*

[Flight controls, engine mounts, and other flight structure located in designated fire zones, or in adjacent areas that would be subjected to the effects of fire in the designated fire zones, must be constructed of fireproof material or be shielded so that they are capable of withstanding the effects of a fire. Engine vibration isolators must incorporate suitable features to ensure that the engine is retained if the non-fireproof portions of the isolators deteriorate from the effects of a fire.]

(Change 523-4 (96-09-01))
(Change 523-5)

[Electrical Bonding And Lightning Protection]

523.867 *[Electrical Bonding and Protection Against Lightning and Static Electricity]*

(a) The aeroplane must be protected against catastrophic effects from lightning.

(b) For metallic components, compliance with paragraph (a) of this section may be shown by:

(1) Bonding the components properly to the airframe; or

(2) Designing the components so that a strike will not endanger the aeroplane.

(c) For non-metallic components, compliance with paragraph (a) of this section may be shown by:

(1) Designing the components to minimize the effect of a strike; or

(2) Incorporating acceptable means of diverting the resulting electrical current so as not to endanger the aeroplane.

(Change 523-5)

Miscellaneous

523.871 *Levelling Means*

There must be means for determining when the aeroplane is in a level position on the ground.

SUBCHAPTER E

Powerplant - General

523.901 *Installation*

(a) For the purpose of this Chapter, the aeroplane powerplant installation includes each component that:

(1) Is necessary for propulsion; and

(2) Affects the safety of the major propulsive units.

(b) Each powerplant installation must be constructed and arranged to:

(1) Ensure safe operation to the maximum altitude for which approval is requested.

(2) Be accessible for necessary inspections and maintenance.

(c) Engine cowls and nacelles must be easily removable or openable by the pilot to provide adequate access to and exposure of the engine compartment for pre-flight checks.

(d) Each turbine engine installation must be constructed and arranged to:

(1) Result in carcass vibration characteristics that do not exceed those established during the type certification of the engine.

(2) Ensure that the capability of the installed engine to withstand the ingestion of rain, hail, ice, and birds into the engine inlet is not less than the capability established for the engine itself under 523.903(a)(2).

(e) The installation must comply with:

(1) The instructions provided under the engine type certificate and the propeller type certificate.

(2) The applicable provisions of this subchapter.

(f) Each auxiliary power unit installation must meet the applicable portions of this chapter.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

523.903 *Engines*

(a) *Engine type certificate.*

(1) Each engine must have a type certificate and must meet the applicable requirements of Chapter 516, subchapter B of this Manual.

FAR:

Each engine must have a type certificate and must meet the applicable requirements of Part 34 of this Chapter.

(2) Each turbine engine and its installation must comply with one of the following:

(i) Sections 533.76, 533.77 and 533.78 of this manual in effect on 5 March, 2001, or as subsequently amended; or
(amended 2004/06/08)

(ii) Sections 533.77 and 533.78 of this manual in effect on 29 October, 1998, or as subsequently amended before 5 March 2001; or

(iii) Either of:

(A) FAR 33.77 in effect on 31 October 1974, or as subsequently amended prior to 1 January 1986, and must have a foreign object ingestion service history that has not resulted in any unsafe condition; or

(B) After 1 January 1986, section 533.77 of this manual, or as subsequently amended prior to 29 October 1998, and must have a foreign object ingestion service history that has not resulted in any unsafe condition; or

(iv) Be shown to have a foreign object ingestion service history in similar installation locations which has not resulted in any unsafe condition.

FAR:

(2) Each turbine engine and its installation must comply with one of the following:

(i) Sections 33.76, 33.77 and 33.78 of this chapter in effect on December 13, 2000, or as subsequently amended; or
(amended 2004/06/08)

(ii) Sections 33.77 and 33.78 of this chapter in effect on April 30, 1998, or as subsequently amended before December 13, 2000; or

(iii) Section 33.77 of this chapter in effect on October 31, 1974, or subsequently amended before April 30, unless that engine's foreign object ingestion service history has resulted in an unsafe condition; or

(iv) Be shown to have a foreign object ingestion service history in similar installation locations which has not resulted in any unsafe condition.

(b) *Turbine engine installations.* For turbine engine installations:

(1) Design precautions must be taken to minimize the hazards to the aeroplane in the event of an engine rotor failure or of a fire originating inside the engine which burns through the engine case.

(2) The powerplant systems associated with engine control devices, systems, and instrumentation must be designed to give reasonable assurance that those operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

(c) *Engine Isolation.* The powerplants must be arranged and isolated from each other to allow operation, in at least one configuration, so that the failure or malfunction of any engine, or the failure or malfunction (including destruction by fire in the engine compartment) of any system that can affect an engine (other than a fuel tank if only one fuel tank is installed), will not:

(1) Prevent the continued safe operation of the remaining engines; or

(2) Require immediate action by any crewmember for continued safe operation of the remaining engines.

(d) Starting and stopping (piston engine).

(1) The design of the installation must be such that risk of fire or mechanical damage to the engine or aeroplane, as a result of starting the engine in any conditions in which starting is to be permitted, is reduced to a minimum. Any techniques and associated limitations for engine starting must be established and included in the Aeroplane Flight Manual, approved manual material, or applicable operating placards. Means must be provided for:

(i) Restarting any engine of a multi-engine aeroplane in flight, and

(ii) Stopping any engine in flight, after engine failure, if continued engine rotation would cause a hazard to the aeroplane.

(2) In addition, for commuter category aeroplanes, the following apply:

(i) Each component of the stopping system on the engine side of the firewall that might be exposed to fire must be at least fire resistant.

(ii) If hydraulic propeller feathering systems are used for this purpose, the feathering lines must be at least fire resistant under the operating conditions that may be expected to exist during feathering.

(e) *Starting and stopping (turbine engine.)* Turbine engine installations must comply with the following:

(1) The design of the installation must be such that risk of fire or mechanical damage to the engine or the aeroplane, as a result of starting the engine in any conditions in which starting is to be permitted, is reduced to a minimum. Any techniques and associated limitations must be established and included in the Aeroplane Flight Manual, approved manual material, or applicable operating placards.

(2) There must be means for stopping combustion within any engine and for stopping the rotation of any engine if continued rotation would cause a hazard to the aeroplane. Each component of the engine stopping system located in any fire zone must be fire resistant. If hydraulic propeller feathering systems are used for stopping the engine, the hydraulic feathering lines or hoses must be fire resistant.

(3) It must be possible to restart an engine in flight. Any techniques and associated limitations must be established and included in the Aeroplane Flight Manual, approved manual material, or applicable operating placards.

(4) It must be demonstrated in flight that when restarting engines following a false start, all fuel or vapour is discharged in such a way that it does not constitute a fire hazard.

(f) *Restart envelope.* An altitude and airspeed envelope must be established for the aeroplane for in-flight engine restarting and each installed engine must have a restart capability within that envelope.

(g) *Restart capability.* For turbine engine powered aeroplanes, if the minimum windmilling speed of the engines, following the in-flight shutdown of all engines, is insufficient to provide the necessary electrical power for engine ignition, a power source independent of the engine-driven electrical power generating system must be provided to permit in-flight engine ignition for restarting.

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))
(Change 523-4 (96-09-01))
(Change 523-5)

523.904 *Automatic Power Reserve System*

If installed, an automatic power reserve (APR) system that automatically advances the power or thrust on the operating engine(s), when any engine fails during takeoff, must comply with Appendix H of this chapter.

(Change 523-4 (96-09-01))

523.905 *Propellers*

(a) Each propeller must have a type certificate.

(b) Engine power and propeller shaft rotational speed may not exceed the limits for which the propeller is certificated.

(c) Each featherable propeller must have a means to unfeather it in flight.

(d) The propeller blade pitch control system must meet the requirements of 535.21, 535.23, 535.42 and 535.43 of this Manual.
(amended 2010/01/29)

(e) All areas of the aeroplane forward of the pusher propeller that are likely to accumulate and shed ice into the propeller disc during any operating condition must be suitably protected to prevent ice formation, or it must be shown that any ice shed into the propeller disc will not create a hazardous condition.

(f) Each pusher propeller must be marked so that the disc is conspicuous under normal daylight ground conditions.

(g) If the engine exhaust gases are discharged into the pusher propeller disc, it must be shown by tests, or analysis supported by tests, that the propeller is capable of continuous safe operation.

(h) All engine cowling, access doors, and other removable items must be designed to ensure that they will not separate from the aeroplane and contact the pusher propeller.

(Change 523-4 (96-09-01))

523.907 *Propeller Vibration and Fatigue*
(amended 2010/01/29)

This section does not apply to fixed-pitch wood propellers of conventional design.
(amended 2010/01/29)

(a) The applicant must determine the magnitude of the propeller vibration stresses or loads, including any stress peaks and resonant conditions, throughout the operational envelope of the aeroplane by either:
(amended 2010/01/29)

(1) Measurement of stresses or loads through direct testing or analysis based on direct testing of the propeller on the aeroplane and engine installation for which approval is sought; or
(amended 2010/01/29)

(2) Comparison of the propeller similar propellers installed on similar aeroplane installations for which these measurements have been made;
(amended 2010/01/29)

(b) The applicant must demonstrate by tests, analysis based on tests or previous experience on similar designs that the propeller does not experience harmful effects of flutter throughout the operational envelope of the aeroplane.
(amended 2010/01/29)

(c) The applicant must perform an evaluation of the propeller to show that failure due to fatigue will be avoided throughout the operational life of the propeller using the fatigue and structural data obtained in accordance with *Airworthiness Manual* Chapter 535 and the vibration data obtained from compliance with paragraph (a) of this section. For the purpose of this paragraph, the propeller includes the hub, blades, blade retention component and any other propeller component whose failure due to fatigue could be catastrophic to the aeroplane. This evaluation must include:
(amended 2010/01/29)

(1) The intended loading spectra including all reasonably foreseeable propeller vibration and cyclic load patterns, identified emergency conditions, allowable overspeeds and overtorques and the effects of temperatures and humidity expected in service.
(amended 2010/01/29)

(2) The effects of aeroplane and propeller operating and airworthiness limitations.
(amended 2010/01/29)

(Change 523-5)

523.909 *Turbocharger Systems*

(a) Each turbocharger must be approved under the engine type certificate or it must be shown that the turbocharger system, while in its normal engine installation and operating in the engine environment:

(1) Can withstand, without defect, an endurance test of 150 hours that meets the applicable requirements of 533.49 of this Manual; and

(2) Will have no adverse effect upon the engine.

(b) Control system malfunctions, vibrations, and abnormal speeds and temperatures expected in service may not damage the turbocharger compressor or turbine.

(c) Each turbocharger case must be able to contain fragments of a compressor or turbine that fails at the highest speed that is obtainable with normal speed control devices inoperative.

(d) Each intercooler installation, where provided, must comply with the following:

(1) The mounting provisions of the intercooler must be designed to withstand the loads imposed on the system;

(2) It must be shown that, under the installed vibration environment, the intercooler will not fail in a manner allowing portions of the intercooler to be ingested by the engine; and

(3) Airflow through the intercooler must not discharge directly on any aeroplane component (e.g., windshield) unless such discharge is shown to cause no hazard to the aeroplane under all operating conditions.

(e) Engine power, cooling characteristics, operating limits, and procedures affected by the turbocharger system installations must be evaluated. Turbocharger operating procedures and limitations must be included in the *Aeroplane Flight Manual* in accordance with 523.1581 of this chapter.

(Change 523-4 (96-09-01))

523.925 *Propeller Clearance*

Unless smaller clearances are substantiated, propeller clearances, with the aeroplane at the most adverse combination of weight and centre of gravity, and with the propeller in the most adverse pitch position, may not be less than the following:

(a) *Ground clearance.* There must be a clearance of at least seven inches (for each aeroplane with nose wheel landing gear) or nine inches (for each aeroplane with tail wheel landing gear) between each propeller and the ground with the landing gear statically deflected and in the level, normal takeoff, or taxiing attitude, whichever is most critical. In addition, for each aeroplane with conventional landing gear struts using fluid or mechanical means for absorbing landing shocks, there must be positive clearance between the propeller and the ground in the level takeoff attitude with the critical tire completely deflated and the corresponding landing gear strut bottom. Positive clearance for aeroplanes using leaf spring struts is shown with a deflection corresponding to 1.5g.

(b) *Aft-mounted propellers.* In addition to the clearances specified in paragraph (a) of this section, an aeroplane with an aft mounted propeller must be designed such that the propeller will not contact the runway surface when the aeroplane is in the maximum pitch attitude attainable during normal takeoffs and landings.

(c) *Water clearance.* There must be a clearance of at least 18 inches between each propeller and the water, unless compliance with 523.239 can be shown with a lesser clearance.

(d) Structural clearance. There must be:

(1) At least one inch radial clearance between the blade tips and the aeroplane structure, plus any additional radial clearance necessary to prevent harmful vibration;

(2) At least one-half inch longitudinal clearance between the propeller blades or cuffs and stationary parts of the aeroplane; and

(3) Positive clearance between other rotating parts of the propeller or spinner and stationary parts of the aeroplane.

(Change 523-4 (96-09-01))
(Change 523-5)

523.929 *Engine Installation Ice Protection*

Propellers (except wooden propellers) and other components of complete engine installations must be protected against the accumulation of ice as necessary to enable satisfactory functioning without appreciable loss of thrust when operated in the icing conditions for which certification is requested.

(Change 523-5)

523.933 *Reversing Systems*

(a) For turbojet and turbofan reversing systems:

(1) Each system intended for ground operation only must be designed so that, during any reversal in flight, the engine will produce no more than flight idle thrust. In addition, it must be shown by analysis or test, or both, that:

(i) Each operable reverser can be restored to the forward thrust position; or

(ii) The aeroplane is capable of continued safe flight and landing under any possible position of the thrust reverser.

(2) Each system intended for in-flight use must be designed so that no unsafe condition will result during normal operation of the system, or from any failure, or likely combination of failures, of the reversing system under any operating condition including ground operation. Failure of structural elements need not be considered if the probability of this type of failure is extremely remote.

(3) Each system must have a means to prevent the engine from producing more than idle thrust when the reversing system malfunctions; except that it may produce any greater thrust that is shown to allow directional control to be maintained, with aerodynamic means alone, under the most critical reversing condition expected in operation.

(b) For propeller reversing systems:

(1) Each system must be designed so that no single failure, likely combination of failures or malfunction of the system will result in unwanted reverse thrust under any operating condition. Failure of structural elements need not be considered if the probability of this type of failure is extremely remote.

(2) Compliance with paragraph (b)(1) of this section must be shown by failure analysis, or testing, or both, for propeller systems that allow the propeller blades to move from the flight low-pitch position to a position that is substantially less than the normal flight, low-pitch position. The analysis may include or be supported by the analysis made to show compliance with 535.21 for the type certificate of the propeller and associated installation components. Credit will be given for pertinent analysis and testing completed by the engine and propeller manufacturers.

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))
(Change 523-4 (96-09-01))
(Change 523-5)

523.934 *Turbojet and Turbofan Engine Thrust Reverser Systems Tests*

Thrust reverser systems of turbojet or turbofan engines must meet the requirements of 533.97 of this manual or it must be demonstrated by tests that engine operation and vibratory levels are not affected.

(Change 523-4 (96-09-01))

523.937 *Turbo Propeller-drag Limiting Systems*

(a) Turbo propeller-powered aeroplane propeller-drag limiting systems must be designed so that no single failure or malfunction of any of the systems during normal or emergency operation results in propeller drag in excess of that for which the aeroplane was designed under the structural requirements of this Chapter. Failure of structural elements of the drag limiting systems need not be considered if the probability of this kind of failure is extremely remote.

(b) As used in this section, drag limiting systems include manual or automatic devices that, when actuated after engine power loss, can move the propeller blades toward the feather position to reduce windmilling drag to a safe level.

(Change 523-4 (96-09-01))

523.939 *Powerplant Operating Characteristics*

(a) Turbine engine powerplant operating characteristics must be investigated in flight to determine that no adverse characteristics (such as stall, surge, or flameout) are present, to a hazardous degree, during normal and emergency operations within the range of operating limitations of the aeroplane and of the engine.

(b) Turbocharged reciprocating engine operating characteristics must be investigated in flight to assure that no adverse characteristics, as a result of an inadvertent overboost,

surge, flooding, or vapour lock, are present during normal or emergency operation of the engine(s) throughout the range of operating limitations of both aeroplane and engine.

(c) For turbine engines, the air inlet system must not, as a result of airflow distortion during normal operation, cause vibration harmful to the engine.

(Change 523-3 (92-01-02))

523.943 *Negative Acceleration*

No hazardous malfunction of an engine, an auxiliary power unit approved for use in flight, or any component or system associated with the powerplant or auxiliary power unit may occur when the aeroplane is operated at the negative accelerations within the flight envelopes prescribed in 523.333. This must be shown for the greatest value and duration of the acceleration expected in service.

(Change 523-4 (96-09-01))

Fuel System

523.951 *General*

(a) Each fuel system must be constructed and arranged to ensure fuel flow at a rate and pressure established for proper engine and auxiliary power unit functioning under each likely operating condition, including any manoeuvre for which certification is requested and during which the engine or auxiliary power unit is permitted to be in operation.

(b) Each fuel system must be arranged so that:

(1) No fuel pump can draw fuel from more than one tank at a time; or

(2) There are means to prevent introducing air into the system.

(c) Each fuel system for a turbine engine must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 80° F. and having 0.75 cc of free water per gallon added and cooled to the most critical condition for icing likely to be encountered in operation.

<u>(d) Each fuel system for a turbine engine powered aeroplane must meet the applicable fuel venting requirements of *Airworthiness Manual* Chapter 516, subchapter B of this Manual.</u>

FAR: each fuel system for a turbine engine powered airplane must meet the applicable fuel venting requirements of part 34 of this chapter.

(Change 523-3 (92-01-02))
(Change 523-4 (96-09-01))

523.953 *Fuel System Independence*

(a) Each fuel system for a multi-engine aeroplane must be arranged so that, in at least one system configuration, the failure of any one component (other than a fuel tank) will not result in the loss of power of more than one engine or require immediate action by the pilot to prevent the loss of power of more than one engine.

(b) If a single fuel tank (or series of fuel tanks interconnected to function as a single fuel tank) is used on a multi-engine aeroplane, the following must be provided:

(1) Independent tank outlets for each engine, each incorporating a shut-off valve at the tank. This shut-off valve may also serve as the fire wall shut-off valve required if the line between the valve and the engine compartment does not contain more than one quart of fuel (or any greater amount shown to be safe) that can escape into the engine compartment.

(2) At least two vents arranged to minimize the probability of both vents becoming obstructed simultaneously.

(3) Filler caps designed to minimize the probability of incorrect installation or in-flight loss.

(4) A fuel system in which those parts of the system from each tank outlet to any engine are independent of each part of the system supplying fuel to any other engine.

(Change 523-4 (96-09-01))

523.954 *Fuel System Lightning Protection*

The fuel system must be designed and arranged to prevent the ignition of fuel vapour within the system by:

(a) Direct lightning strikes to areas having a high probability of stroke attachment;

(b) Swept lightning strokes on areas where swept strokes are highly probable; and

(c) Corona or streamering at fuel vent outlets.

523.955 *Fuel Flow*

(a) *General.* The ability of the fuel system to provide fuel at the rates specified in this section and at a pressure sufficient for proper engine operation must be shown in the attitude that is most critical with respect to fuel feed and quantity of unusable fuel. These conditions may be simulated in a suitable mock-up. In addition:

(1) The quantity of fuel in the tank may not exceed the amount established as the unusable fuel supply for that tank under 523.959(a) plus that quantity necessary to show compliance with this section.

(2) If there is a fuel flow meter, it must be blocked during the flow test and the fuel must flow through the meter or its bypass.

(3) If there is a flow meter without a bypass, it must not have any probable failure mode that would restrict fuel flow below the level required for this fuel demonstration.

(4) The fuel flow must include that flow necessary for vapour return flow, jet pump drive flow, and for all other purposes for which fuel is used.

(b) *Gravity systems.* The fuel flow rate for gravity systems (main and reserve supply) must be 150 percent of the takeoff fuel consumption of the engine.

(c) *Pump systems.* The fuel flow rate for each pump system (main and reserve supply) for each reciprocating engine must be 125 percent of the fuel flow required by the engine at the maximum takeoff power approved under this chapter.

(1) This flow rate is required for each main pump and each emergency pump, and must be available when the pump is operating as it would during takeoff;

(2) For each hand-operated pump, this rate must occur at not more than 60 complete cycles (120 single strokes) per minute.

(3) The fuel pressure, with main and emergency pumps operating simultaneously, must not exceed the fuel inlet pressure limits of the engine unless it can be shown that no adverse effect occurs.

(d) *Auxiliary fuel systems and fuel transfer systems.* Paragraphs (b), (c), and (f) of this section apply to each auxiliary and transfer system, except that:

(1) The required fuel flow rate must be established upon the basis of maximum continuous power and engine rotational speed, instead of takeoff power and fuel consumption; and

(2) If there is a placard providing operating instructions, a lesser flow rate may be used for transferring fuel from any auxiliary tank into a larger main tank. This lesser flow rate must be adequate to maintain engine maximum continuous power but the flow rate must not overfill the main tank at lower engine powers.

(e) *Multiple fuel tanks.* For reciprocating engines that are supplied with fuel from more than one tank, if engine power loss becomes apparent due to fuel depletion from the tank selected, it must be possible after switching to any full tank, in level flight, to obtain 75 percent maximum continuous power on that engine in not more than:

(1) 10 seconds for naturally aspirated single-engine aeroplanes;

(2) 20 seconds for turbocharged single-engine aeroplanes, provided that 75 percent maximum continuous naturally aspirated power is regained within 10 seconds; or

(3) 20 seconds for multi-engine aeroplanes.

(f) *Turbine engine fuel systems.* Each turbine engine fuel system must provide at least 100 percent of the fuel flow required by the engine under each intended operation condition and manoeuvre. The conditions may be simulated in a suitable mock-up. This flow must:

(1) Be shown with the aeroplane in the most adverse fuel feed condition (with respect to altitudes, attitudes, and other conditions) that is expected in operation; and

(2) For multi-engine aeroplanes, notwithstanding the lower flow rate allowed by paragraph (d) of this section, be automatically uninterrupted with respect to any engine until all the fuel scheduled for use by that engine has been consumed. In addition:

(i) For the purposes of this section, "fuel scheduled for use by that engine" means all fuel in any tank intended for use by a specific engine.

(ii) The fuel system design must clearly indicate the engine for which fuel in any tank is scheduled.

(iii) Compliance with this paragraph must require no pilot action after completion of the engine starting phase of operations.

(3) For single-engine aeroplanes, require no pilot action after completion of the engine starting phase of operations unless means are provided that unmistakenly alert the pilot to take any needed action at least five minutes prior to the needed action; such pilot action must not cause any change in engine operation; and such pilot action must not distract pilot attention from essential flight duties during any phase of operations for which the aeroplane is approved.

(Change 523-4 (96-09-01))
(Change 523-5)

523.957 *Flow Between Interconnected Tanks*

(a) It must be impossible, in a gravity feed system with interconnected tank outlets, for enough fuel to flow between the tanks to cause an overflow of fuel from any tank vent under the conditions in 523.959 except that full tanks must be used.

(b) If fuel can be pumped from one tank to another in flight, the fuel tank vents and the fuel transfer system must be designed so that no structural damage to any aeroplane component can occur because of overfilling of any tank.

(Change 523-4 (96-09-01))

523.959 *Unusable Fuel Supply*

(a) The unusable fuel supply for each tank must be established as not less than that quantity at which the first evidence of malfunctioning occurs under the most adverse fuel feed condition occurring under each intended operation and flight manoeuvre involving that tank. Fuel system component failures need not be considered.

(b) The effect on the usable fuel quantity as a result of a failure of any pump shall be determined.

(Change 523-5)

523.961 *Fuel System Hot Weather Operation*

Each fuel system must be free from vapour lock when using fuel at its critical temperature, with respect to vapour formation, when operating the aeroplane in all critical operating and environmental conditions for which approval is requested. For turbine fuel, the initial temperature must be 110° F (43.3° C), -0° F (-18° C), +5° F (-15° C) or the maximum outside air temperature for which approval is requested, whichever is more critical.
(amended 2010/05/27)

(Change 523-4 (96-09-01))

523.963 *Fuel Tanks: General*

(a) Each fuel tank must be able to withstand, without failure, the vibration, inertia, fluid, and structural loads that it may be subjected to in operation.

(b) Each flexible fuel tank liner must be shown to be suitable for the particular application.

(c) Each integral fuel tank must have adequate facilities for interior inspection and repair.

(d) The total usable capacity of the fuel tanks must be enough for at least one-half hour of operation at maximum continuous power.

(e) Each fuel quantity indicator must be adjusted, as specified in 523.1337 (b), to account for the unusable fuel supply determined under 523.959(a).

(f) (Removed)

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

525.965 *Fuel Tank Tests*

(a) Each fuel tank must be able to withstand the following pressures without failure or leakage:

(1) For each conventional metal tank and non-metallic tank with walls not supported by the aeroplane structure, a pressure of 3.5 p.s.i., or that pressure developed during maximum ultimate acceleration with a full tank, whichever is greater.

(2) For each integral tank, the pressure developed during the maximum limit acceleration of the aeroplane with a full tank, with simultaneous application of the critical limit structural loads.

(3) For each non-metallic tank with walls supported by the aeroplane structure and constructed in an acceptable manner using acceptable basic tank material, and with actual or simulated support conditions, a pressure of 2 p.s.i. for the first tank of a specific design. The supporting structure must be designed for the critical loads occurring in the flight or landing strength conditions combined with the fuel pressure loads resulting from the corresponding accelerations.

(b) Each fuel tank with large, unsupported, or unstiffened flat surfaces, whose failure or deformation could cause fuel leakage, must be able to withstand the following test without leakage, failure, or excessive deformation of the tank walls:

(1) Each complete tank assembly and its support must be vibration tested while mounted to simulate the actual installation.

(2) Except as specified in paragraph (b)(4) of this section, the tank assembly must be vibrated for 25 hours at a total displacement of not less than 1/32 of an inch (unless another displacement is substantiated) while 2/3 filled with water or other suitable test fluid.

(3) The test frequency of vibration must be as follows:

(i) If no frequency of vibration resulting from any rpm within the normal operating range of engine or propeller speeds is critical, the test frequency of vibration is:

(A) The number of cycles per minute obtained by multiplying the maximum continuous propeller speed in rpm by 0.9 for propeller-driven aeroplanes, and

(B) For non-propeller driven aeroplanes the test frequency of vibration is 2,000 cycles per minute.

(ii) If only one frequency of vibration resulting from any rpm within the normal operating range of engine or propeller speeds is critical, that frequency of vibration must be the test frequency.

(iii) If more than one frequency of vibration resulting from any rpm within the normal operating range of engine or propeller speeds is critical, the most critical of these frequencies must be the test frequency.

(4) Under subparagraphs (3)(ii) and (iii) of this paragraph, the time of test must be adjusted to accomplish the same number of vibration cycles that would be accomplished in 25 hours at the frequency specified in subparagraph (3)(i) of this paragraph.

(5) During the test, the tank assembly must be rocked at a rate of 16 to 20 complete cycles per minute, through an angle of 15° on either side of the horizontal (30° total), about an axis parallel to the axis of the fuselage, for 25 hours.

(c) Each integral tank using methods of construction and sealing not previously proven to be adequate by test data or service experience must be able to withstand the vibration test specified in subparagraphs (1) through (4) of paragraph (b).

(d) Each tank with a non-metallic liner must be subjected to the sloshing test outlined in subparagraph (5) of paragraph (b) of this section, with the fuel at room temperature. In addition, a specimen liner of the same basic construction as that to be used in the aeroplane must, when installed in a suitable test tank, withstand the sloshing test with fuel at a temperature of 110°F.

(Change 523-4 (96-09-01))
(Change 523-5)

523.967 *Fuel Tank Installation*

(a) Each fuel tank must be supported so that tank loads are not concentrated. In addition:

(1) There must be pads, if necessary, to prevent chafing between each tank and its supports;

(2) Padding must be non-absorbent or treated to prevent the absorption of fuel;

(3) If a flexible tank liner is used, it must be supported so that it is not required to withstand fluid loads;

(4) Interior surfaces adjacent to the liner must be smooth and free from projections that could cause wear, unless:

(i) Provisions are made for protection of the liner at those points; or

(ii) The construction of the liner itself provides such protection;

(5) A positive pressure must be maintained within the vapour space of each bladder cell under all conditions of operation except for a particular condition for which it is shown that a zero or negative pressure will not cause the bladder cell to collapse; and

(6) Siphoning of fuel (other than minor spillage) or collapse of bladder fuel cells may not result from improper securing or loss of the fuel filler cap.

(b) Each tank compartment must be ventilated and drained to prevent the accumulation of flammable fluids or vapours. Each compartment adjacent to a tank that is an integral part of the aeroplane structure must also be ventilated and drained.

(c) No fuel tank may be on the engine side of the firewall. There must be at least one-half inch of clearance between the fuel tank and the firewall. No part of the engine nacelle skin that lies immediately behind a major air opening from the engine compartment may act as the wall of an integral tank.

(d) Each fuel tank must be isolated from personnel compartments by a fume-proof and fuel-proof enclosure that is vented and drained to the exterior of the aeroplane. The required enclosure must sustain any personnel compartment pressurisation loads without permanent deformation or failure under the conditions of 523.365 and 523.843 of this chapter. A bladder-type fuel cell, if used, must have a retaining shell at least equivalent to a metal fuel tank in structural integrity.

(e) Fuel tanks must be designed, located, and installed so as to retain fuel:

(1) When subjected to the inertia loads resulting from the ultimate static load factors prescribed in 523.561(b)(2) of this Chapter; and

(2) Under conditions likely to occur when an aeroplane lands on a paved runway at a normal landing speed under each of the following conditions:

(i) The aeroplane in a normal landing attitude and its landing gear retracted.

(ii) The most critical landing gear leg collapsed and the other landing gear legs extended.

In showing compliance with paragraph (e) (2) of this section, the tearing away of an engine mount must be considered unless all the engines are installed above the wing or on the tail or fuselage of the aeroplane.

(Change 523-2 (89-01-01))
(Change 523-4 (96-09-01))

523.969 *Fuel Tank Expansion Space*

Each fuel tank must have an expansion space of not less than two percent of the tank capacity, unless the tank vent discharges clear of the aeroplane (in which case no expansion space is required). It must be impossible to fill the expansion space inadvertently with the aeroplane in the normal ground attitude.

523.971 *Fuel Tank Sump*

(a) Each fuel tank must have a drainable sump with an effective capacity, in the normal ground and flight attitudes, of 0.25 percent of the tank capacity, or 1/16 gallon, whichever is greater.

(b) Each fuel tank must allow drainage of any hazardous quantity of water from any part of the tank to its sump with the aeroplane in the normal ground attitude.

(c) Each reciprocating engine fuel system must have a sediment bowl or chamber that is accessible for drainage; has a capacity of 1 ounce for every 20 gallons of fuel tank capacity; and each fuel tank outlet is located so that, in the normal flight attitude, water will drain from all parts of the tank except the sump to the sediment bowl or chamber.

(d) Each sump, sediment bowl, and sediment chamber drain required by paragraphs (a), (b), and (c) of this section must comply with the drain provisions of 523.999(b)(1) and (b)(2).

(Change 523-4 (96-09-01))

523.973 *Fuel Tank Filler Connection*

(a) Each fuel tank filler connection must be marked as prescribed in 523.1557(c).

(b) Spilled fuel must be prevented from entering the fuel tank compartment or any part of the aeroplane other than the tank itself.

(c) Each filler cap must provide a fuel tight seal for the main filler opening. However, there may be small openings in the fuel tank cap for venting purposes or for the purpose of allowing passage of a fuel gauge through the cap provided such openings comply with the requirements of 523.975(a).

(d) Each fuel filling point, except pressure fuelling connection points, must have a provision for electrically bonding the aeroplane to ground fuelling equipment.

(e) For aeroplanes with engines requiring gasoline as the only permissible fuel, the inside diameter of the fuel filler opening must be no larger than 2.36 inches.

(f) For aeroplanes with turbine engines, the inside diameter of the fuel filler opening must be no smaller than 2.95 inches.

(Change 523-4 (96-09-01))
(Change 523-5)

523.975 *Fuel Tank Vents and Carburettor Vapour Vents*

(a) Each fuel tank must be vented from the top part of the expansion space. In addition:

(1) Each vent outlet must be located and constructed in a manner that minimizes the possibility of its being obstructed by ice or other foreign matter;

(2) Each vent must be constructed to prevent siphoning of fuel during normal operation;

(3) The venting capacity must allow the rapid relief of excessive differences of pressure between the interior and exterior of the tank;

(4) Airspaces of tanks with inter-connected outlets must be inter-connected;

(5) There may be no point in any vent line where moisture can accumulate with the aeroplane in either the ground or level flight attitudes, unless drainage is provided. Any drain valve installed must be accessible for drainage;

(6) No vent may terminate at a point where the discharge of fuel from the vent outlet will constitute a fire hazard or from which fumes may enter personnel compartments; and

(7) Vents must be arranged to prevent the loss of fuel, except fuel discharged because of thermal expansion, when the aeroplane is parked in any direction on a ramp having a one-percent slope.

(b) Each carburettor with vapour elimination connections and each fuel injection engine employing vapour return provisions must have a separate vent line to lead vapours back to the top of one of the fuel tanks. If there is more than one tank and it is necessary to use these tanks in a definite sequence for any reason, the vapour vent line must lead back to the fuel tank to be used first, unless the relative capacities of the tanks are such that return to another tank is preferable.

(c) For acrobatic category aeroplanes, excessive loss of fuel during acrobatic manoeuvres, including short periods of inverted flight, must be prevented. It must be impossible for fuel to siphon from the vent when normal flight has been resumed after any acrobatic manoeuvre for which certification is requested.

(Change 523-4 (96-09-01))
(Change 523-5)

523.977 *Fuel Tank Outlet*

(a) There must be a fuel strainer for the fuel tank outlet or for the booster pump. This strainer must:

(1) For reciprocating engine powered aeroplanes, have 8 to 16 meshes per inch; and

(2) For turbine engine powered aeroplanes, prevent the passage of any object that could restrict fuel flow or damage any fuel system component.

(b) The clear area of each fuel tank outlet strainer must be at least five times the area of the outlet line.

(c) The diameter of each strainer must be at least that of the fuel tank outlet.

(d) Each strainer must be accessible for inspection and cleaning.

(Change 523-4 (96-09-01))

523.979 *Pressure Fuelling Systems*

For pressure fuelling systems, the following apply:

(a) Each pressure fuelling system fuel manifold connection must have means to prevent the escape of hazardous quantities of fuel from the system if the fuel entry valve fails.

(b) An automatic shut-off means must be provided to prevent the quantity of fuel in each tank from exceeding the maximum quantity approved for that tank. This means must:

(1) Allow checking for proper shut-off operation before each fuelling of the tank; and

(2) For commuter category aeroplanes, indicate at each fuelling station, a failure of the shut-off means to stop the fuel flow at the maximum quantity approved for that tank.

(c) A means must be provided to prevent damage to the fuel system in the event of failure of the automatic shut-off means prescribed in paragraph (b) of this section.

(d) All parts of the fuel system up to the tank which are subjected to fuelling pressures must have a proof pressure of 1.33 times, and an ultimate pressure of at least 2.0 times, the surge pressure likely to occur during fuelling.

(Change 523-5)

Fuel System Components

523.991 *Fuel Pumps*

(a) *Main pumps.* For main pumps, the following apply:

(1) For reciprocating engine installations having fuel pumps to supply fuel to the engine, at least one pump for each engine must be directly driven by the engine and must meet 523.955. This pump is a main pump.

(2) For turbine engine installations, each fuel pump required for proper engine operations, or required to meet the fuel system requirements of this subchapter (other than those in paragraph (b) of this section), is a main pump. In addition:

(i) There must be at least one main pump for each turbine engine;

(ii) The power supply for the main pump for each engine must be independent of the power supply for each main pump for any other engine; and

(iii) For each main pump, provision must be made to allow the bypass of each positive displacement fuel pump other than a fuel injection pump approved as part of the engine.

(b) *Emergency pumps.* There must be an emergency pump immediately available to supply fuel to the engine if any main pump (other than a fuel injection pump approved as part of an engine) fails. The power supply for each emergency pump must be independent of the power supply for each corresponding main pump.

(c) *Warning Means.* If both the main pump and emergency pump operate continuously, there must be a means to indicate to the appropriate flight crew members a malfunction of either pump.

(d) Operation of any fuel pump may not affect engine operation so as to create a hazard, regardless of the engine power or thrust setting or the functional status of any other fuel pump.

(Change 523-4 (96-09-01))

523.993 *Fuel System Lines and Fittings*

(a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.

(b) Each fuel line connected to components of the aeroplane between which relative motion could exist must have provisions for flexibility.

(c) Each flexible connection in fuel lines that may be under pressure and subjected to axial loading must use flexible hose assemblies.

(d) Each flexible hose must be shown to be suitable for the particular application.

(e) No flexible hose that might be adversely affected by exposure to high temperatures may be used where excessive temperatures will exist during operation or after engine shutdown.

(Change 523-4 (96-09-01))

523.994 *Fuel System Components*

Fuel system components in an engine nacelle or in the fuselage must be protected from damage which could result in spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway.

523.995 *Fuel Valves and Controls*

(a) There must be a means to allow appropriate flight crew members to rapidly shut off, in flight, the fuel to each engine individually.

(b) No shut-off valve may be on the engine side of any firewall. In addition, there must be means to:

(1) Guard against inadvertent operation of each shut-off valve; and

(2) Allow appropriate flight crew members to reopen each valve rapidly after it has been closed.

(c) Each valve and fuel system control must be supported so that loads resulting from its operation or from accelerated flight conditions are not transmitted to the lines connected to the valve.

(d) Each valve and fuel system control must be installed so that gravity and vibration will not affect the selected position.

(e) Each fuel valve handle and its connections to the valve mechanism must have design features that minimize the possibility of incorrect installation.

(f) Each check valve must be constructed, or otherwise incorporate provisions, to preclude incorrect assembly or connection of the valve.

(g) Fuel tank selector valves must:

(1) Require a separate and distinct action to place the selector in the "OFF" position; and

(2) Have the tank selector positions located in such a manner that it is impossible for the selector to pass through the "OFF" position when changing from one tank to another.

523.997 *Fuel Strainer or Filter*

There must be a fuel strainer or filter between the fuel tank outlet and the inlet of either the fuel metering device or an engine driven positive displacement pump, whichever is nearer the fuel tank outlet. This fuel strainer or filter must:

(a) Be accessible for draining and cleaning and must incorporate a screen or element which is easily removable;

(b) Have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes;

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

(d) Have the capacity (with respect to operating limitations established for the engine) to ensure that engine fuel system functioning is not impaired, with the fuel contaminated to a degree (with respect to particle size and density) that is greater than that established for the engine during its type certificate.

(e) In addition, for commuter category aeroplanes, unless means are provided in the fuel system to prevent the accumulation of ice on the filter, a means must be provided to automatically maintain the fuel flow if ice clogging of the filter occurs.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))

523.999 *Fuel System Drains*

(a) There must be at least one drain to allow safe drainage of the entire fuel system with the aeroplane in its normal ground attitude.

(b) Each drain required by paragraph (a) of this section and 523.971 must:

(1) Discharge clear of all parts of the aeroplane;

(2) Have a drain valve:

(i) That has manual or automatic means for positive locking in the closed position;

(ii) That is readily accessible;

(iii) That can be easily opened and closed;

(iv) That allows the fuel to be caught for examination;

(v) That can be observed for proper closing; and

(vi) That is either located or protected to prevent fuel spillage in the event of a landing with landing gear retracted.

(Change 523-4 (96-09-01))

523.1001 *Fuel Jettisoning System*

(a) If the design landing weight is less than that permitted under the requirements of 523.473 (b), the aeroplane must have a fuel jettisoning system installed that is able to jettison enough fuel to bring the maximum weight down to the design landing weight. The average rate of fuel jettisoning must be at least 1 percent of the maximum weight per minute, except that the time required to jettison the fuel need not be less than 10 minutes.

(b) Fuel jettisoning must be demonstrated at maximum weight with flaps and landing gear up and in:

(1) A power-off glide at 1.4 V_{S1};

(2) A climb, at the speed at which the one-engine-inoperative enroute climb data have been established in accordance with 523.69(b), with the critical engine inoperative and the remaining engines at maximum continuous power; and

(3) Level flight at 1.4 VS_1, if the results of the tests in the conditions specified in subparagraphs (1) and (2) of this paragraph show that this condition could be critical.

(c) During the flight tests prescribed in paragraph (b) of this section, it must be shown that:

(1) The fuel jettisoning system and its operation are free from fire hazard;

(2) The fuel discharges clear of any part of the aeroplane;

(3) Fuel or fumes do not enter any parts of the aeroplane; and

(4) The jettisoning operation does not adversely affect the controllability of the aeroplane.

(d) For reciprocating engine powered aeroplanes, the jettisoning system must be designed so that it is not possible to jettison the fuel in the tanks used for takeoff and landing below the level allowing 45 minutes flight at 75 percent maximum continuous power. However, if there is an auxiliary control independent of the main jettisoning control, the system may be designed to jettison all the fuel.

(e) For turbine engine powered aeroplanes, the jettisoning system must be designed so that is not possible to jettison fuel in the tanks used for takeoff and landing below the level allowing from sea level to 10,000 feet and thereafter allowing 45 minutes cruise at a speed for maximum range.

(f) The fuel jettisoning valve must be designed to allow flight crewmembers to close the valve during any part of the jettisoning operation.

(g) Unless it is shown that using any means (including flaps, slots and slats) for changing the airflow across or around the wings does not adversely affect fuel jettisoning, there must be a placard, adjacent to the jettisoning control, to warn flight crew members against jettisoning fuel while the means that change the airflow are being used.

(h) The fuel jettisoning system must be designed so that any reasonably probable single malfunction in the system will not result in a hazardous condition due to unsymmetrical jettisoning of, or inability to jettison, fuel.

(Change 523-4 (96-09-01))
(Change 523-5)

Oil System

523.1011 *General*

(a) For oil systems and components that have been approved under the engine airworthiness requirements and where those requirements are equal to or more severe than the corresponding requirements of Subchapter E of this Chapter, that approval need not be duplicated. Where the requirements of subchapter E of this Chapter are more severe, substantiation must be shown to the requirements of Subchapter E of this Chapter.

(b) Each engine must have an independent oil system that can supply it with an appropriate quantity of oil at a temperature not above that safe for continuous operation.

(c) The usable oil tank capacity may not be less than the product of the endurance of the aeroplane under critical operating conditions and the maximum oil consumption of the engine under the same conditions, plus a suitable margin to ensure adequate circulation and cooling.

(d) For an oil system without an oil transfer system, only the usable oil tank capacity may be considered. The amount of oil in the engine oil lines, the oil radiator, and the feathering reserve, may not be considered.

(e) If an oil transfer system is used, and the transfer pump can pump some of the oil in the transfer lines into the main engine oil tanks, the amount of oil in these lines that can be pumped by the transfer pump may be included in the oil capacity.

(Change 523-4 (96-09-01))

523.1013 *Oil Tanks*

(a) *Installation.* Each oil tank must be installed to:

(1) Meet the requirements of 523.967 (a) and (b); and

(2) Withstand any vibration, inertia, and fluid loads expected in operation.

(b) *Expansion space.* Oil tank expansion space must be provided so that:

(1) Each oil tank used with a reciprocating engine has an expansion space of not less than the greater of 10 percent of the tank capacity or 0.5 gallon, and each oil tank used with a turbine engine has an expansion space of not less than 10 percent of the tank capacity; and

(2) It is impossible to fill the expansion space inadvertently with the aeroplane in the normal ground attitude.

(c) *Filler connection.* Each oil tank filler connection must be marked as specified in 523.1557(c). Each recessed oil tank filler connection of an oil tank used with a turbine engine, that can retain any appreciable quantity of oil, must have provisions for fitting a drain.

(d) *Vent.* Oil tanks must be vented as follows:

(1) Each oil tank must be vented to the engine from the top part of the expansion space so that the vent connection is not covered by oil under any normal flight condition.

(2) Oil tank vents must be arranged so that condensed water vapour that might freeze and obstruct the line cannot accumulate at any point.

(3) For acrobatic category aeroplanes, there must be means to prevent hazardous loss of oil during acrobatic manoeuvres, including short periods of inverted flight.

(e) *Outlet.* No oil tank outlet may be enclosed by any screen or guard that would reduce the flow of oil below a safe value at any operating temperature. No oil tank outlet diameter may be less than the diameter of the engine oil pump inlet. Each oil tank used with a turbine engine must have means to prevent entrance into the tank itself, or into the tank outlet, of any object that might obstruct the flow of oil through the system. There must be a shut-off valve at the outlet of each oil tank used with a turbine engine, unless the external portion of the oil system (including oil tank supports) is fireproof.

(f) *Flexible liners.* Each flexible oil tank liner must be of an acceptable kind.

(g) Each oil tank filler cap of an oil tank that is used with an engine must provide an oil tight seal.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1015 *Oil Tank Tests*

Each oil tank must be tested under 523.965 except that:

(a) The applied pressure must be 5 p.s.i. for the tank construction instead of the pressures specified in 523.965 (a);

(b) For a tank with a non-metallic liner the test fluid must be oil rather than fuel as specified in 523.965 (d), and the slosh test on a specimen liner must be conducted with the oil at 250°F; and

(c) For pressurised tanks used with a turbine engine, the test pressure may not be less than 5 p.s.i. plus the maximum operating pressure of the tank.

523.1017 *Oil Lines and Fittings*

(a) *Oil lines.* Oil lines must meet 523.993 and must accommodate a flow of oil at a rate and pressure adequate for proper engine functioning under any normal operating condition.

(b) *Breather lines.* Breather lines must be arranged so that:

(1) Condensed water vapour or oil that might freeze and obstruct the line cannot accumulate at any point;

(2) The breather discharge will not constitute a fire hazard if foaming occurs, or cause emitted oil to strike the pilot's windshield;

(3) The breather does not discharge into the engine air induction system; and

(4) For acrobatic category aeroplanes, there is not excessive loss of oil from the breather during acrobatic manoeuvres, including short periods of inverted flight.

(5) The breather outlet is protected against blockage by ice or foreign matter.

523.1019 *Oil Strainer or Filter*

(a) Each turbine engine installation must incorporate an oil strainer or filter through which all of the engine oil flows and which meets the following requirements:

(1) Each oil strainer or filter that has a bypass, must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter completely blocked.

(2) The oil strainer or filter must have the capacity (with respect to operating limitations established for the engine) to ensure that engine oil system functioning is not impaired when the oil is contaminated to a degree (with respect to particle size and density) that is greater than that established for the engine for its type certificate.

(3) The oil strainer or filter, unless it is installed at an oil tank outlet, must incorporate a means to indicate contamination before it reaches the capacity established in accordance with subparagraph (2) of this paragraph.

(4) The bypass of a strainer or filter must be constructed and installed so that the release of collected contaminants is minimized by appropriate location of the bypass to ensure that collected contaminants are not in the bypass flow path.

(5) An oil strainer or filter that has no bypass, except one that is installed at an oil tank outlet, must have a means to connect it to the warning system required in 523.1305(c)(9).

(b) Each oil strainer or filter in a powerplant installation using reciprocating engines must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter element completely blocked.

(Change 523-4 (96-09-01))

523.1021 *Oil System Drains*

A drain (or drains) must be provided to allow safe drainage of the oil system. Each drain must:

(a) Be accessible;

(b) Have drain valves, or other closures, employing manual or automatic shut-off means for positive locking in the closed position; and

(c) Be located or protected to prevent inadvertent operation.

(Change 523-4 (96-09-01))

523.1023 *Oil Radiators*

Each oil radiator and its supporting structures must be able to withstand the vibration, inertia, and oil pressure loads to which it would be subjected in operation.

523.1027 *Propeller Feathering System*

(a) If the propeller feathering system uses engine oil and that oil supply can become depleted due to failure of any part of the oil system, a means must be incorporated to reserve enough oil to operate the feathering system.

(b) The amount of reserved oil must be enough to accomplish feathering and must be available only to the feathering pump.

(c) The ability of the system to accomplish feathering with the reserved oil must be shown.

(d) Provision must be made to prevent sludge or other foreign matter from affecting the safe operation of the propeller feathering system.

(Change 523-4 (96-09-01))

Cooling

523.1041 *General*

The powerplant and auxiliary power unit cooling provisions must maintain the temperatures of powerplant components and engine fluids, and auxiliary power unit components and fluids within the limits established for those components and fluids under the most adverse ground, water, and flight operations to the maximum altitude and maximum ambient atmospheric temperature conditions for which approval is requested, and after normal engine and auxiliary power unit shutdown.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1043 *Cooling Tests*

(a) *General*. Compliance with 523.1041 must be shown on the basis of tests, for which the following apply:

(1) If the tests are conducted under ambient atmospheric temperature conditions deviating from the maximum for which approval is requested, the recorded powerplant temperatures must be corrected under paragraphs (c) and (d) of this section, unless a more rational correction method is applicable.

(2) No corrected temperature determined under paragraph (a)(1) of this section may exceed established limits.

(3) The fuel used during the cooling tests must be of the minimum grade approved for the engine.

(4) For turbocharged engines, each turbocharger must be operated through that part of the climb profile for which operation with the turbocharger is requested.

(5) For a reciprocating engine, the mixture settings must be the leanest recommended for climb.

(b) *Maximum ambient atmospheric temperature.* A maximum ambient atmospheric temperature corresponding to sea level conditions of at least 100 degrees F must be established. The assumed temperature lapse rate is 3.6 degrees F per thousand feet of altitude above sea level until a temperature of 69.7 degrees F is reached, above which altitude the temperature is considered constant at 69.7 degrees F. However, for winterisation installations, the applicant may select a maximum ambient atmospheric temperature corresponding to sea level conditions of less than 100 F.

(c) *Correction factor (except cylinder barrels).* Temperatures of engine fluids and powerplant components (except cylinder barrels) for which temperature limits are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature for the relevant altitude for which approval has been requested and the temperature of the ambient air at the time of the first occurrence of the maximum fluid or component temperature recorded during the cooling test.

(d) *Correction factor for cylinder barrel temperatures.* Cylinder barrel temperatures must be corrected by adding to them 0.7 times the difference between the maximum ambient atmospheric temperature for the relevant altitude for which approval has been requested and the temperature of the ambient air at the time of the first occurrence of the maximum cylinder barrel temperature recorded during the cooling test.

(Change 523-5)

523.1045 *Cooling Test Procedures for Turbine Engine Powered Aeroplanes*

(a) Compliance with 523.1041 must be shown for all phases of operation. The aeroplane must be flown in the configurations, at the speeds, and following the procedures recommended in the Aeroplane Flight Manual for the relevant stage of flight, that correspond to the applicable performance requirements that are critical to cooling.

(b) Temperatures must be stabilised under the conditions from which entry is made into each stage of flight being investigated, unless the entry condition normally is not one during which component and engine fluid temperatures would stabilise (in which case, operation through the full entry condition must be conducted before entry into the stage of

flight being investigated in order to allow temperatures to reach their natural levels at the time of entry). The takeoff cooling test must be preceded by a period during which the powerplant component and engine fluid temperatures are stabilised with the engines at ground idle.

(c) Cooling tests for each stage of flight must be continued until:

(1) The component and engine fluid temperatures stabilise;

(2) The stage of flight is completed; or

(3) An operating limitation is reached.

(Change 523-5)

523.1047 *Cooling Test Procedures for Reciprocating Engine Powered Aeroplanes*

Compliance with 523.1041 must be shown for the climb (or, for multi-engine aeroplanes with negative one-engine-inoperative rates of climb, the descent) stage of flight. The aeroplane must be flown in the configurations, at the speeds and following the procedures recommended in the Aeroplane Flight Manual, that correspond to the applicable performance requirements that are critical to cooling.

(Change 523-3 (92-01-02))
(Change 523-4 (96-09-01))
(Change 523-5)

Liquid Cooling

523.1061 *Installation*

(a) *General.* Each liquid-cooled engine must have an independent cooling system (including coolant tank) installed so that:

(1) Each coolant tank is supported so that tank loads are distributed over a large part of the tank surface;

(2) There are pads or other isolation means between the tank and its supports to prevent chafing.

(3) Pads or any other isolation means that is used must be non-absorbent or must be treated to prevent absorption of flammable fluids; and

(4) No air or vapour can be trapped in any part of the system, except the coolant tank expansion space, during filling or during operation.

(b) *Coolant tank.* The tank capacity must be at least one gallon, plus 10 percent of the cooling system capacity. In addition:

(1) Each coolant tank must be able to withstand the vibration, inertia, and fluid loads to which it may be subjected in operation;

(2) Each coolant tank must have an expansion space of at least 10 percent of the total cooling system capacity; and

(3) It must be impossible to fill the expansion space inadvertently with the aeroplane in the normal ground attitude.

(c) *Filler connection.* Each coolant tank filler connection must be marked as specified in 523.1557 (c). In addition:

(1) Spilled coolant must be prevented from entering the coolant tank compartment or any part of the aeroplane other than the tank itself; and

(2) Each recessed coolant filler connection must have a drain that discharges clear of the entire aeroplane.

(d) *Lines and fittings.* Each coolant system line and fitting must meet the requirements of 523.993, except that the inside diameter of the engine coolant inlet and outlet lines may not be less than the diameter of the corresponding engine inlet and outlet connections.

(e) *Radiators.* Each coolant radiator must be able to withstand any vibration, inertia, and coolant pressure load to which it may normally be subjected. In addition:

(1) Each radiator must be supported to allow expansion due to operating temperatures and prevent the transmittal of harmful vibration to the radiator; and

(2) If flammable coolant is used, the air intake duct to the coolant radiator must be located so that (in case of fire) flames from the nacelle cannot strike the radiator.

(f) *Drains.* There must be an accessible drain that:

(1) Drains the entire cooling system (including the coolant tank, radiator, and the engine) when the aeroplane is in the normal ground attitude;

(2) Discharges clear of the entire aeroplane; and

(3) Has means to positively lock it closed.

(Change 523-4 (96-09-01))

523.1063 *Coolant Tank Tests*

Each coolant tank must be tested under 523.965, except that:

(a) The test required by 523.965 (a)(1) must be replaced with a similar test using the sum of the pressure developed during the maximum ultimate acceleration with a full tank or a pressure of 3.5 pounds per square inch, whichever is greater, plus the maximum working pressure of the system; and

(b) For a tank with a non-metallic liner the test fluid must be coolant rather than fuel as specified in 523.965 (d), and the slosh test on a specimen liner must be conducted with the coolant at operating temperature.

Induction System

523.1091 *Air Induction System*

(a) The air induction system for each engine and auxiliary power unit and their accessories must supply the air required by that engine and auxiliary power unit and their accessories under the operating conditions for which certification is requested.

(b) Each reciprocating engine installation must have at least two separate air intake sources and must meet the following:

(1) Primary air intakes may open within the cowling if that part of the cowling is isolated from the engine accessory section by a fire-resistant diaphragm or if there are means to prevent the emergence of backfire flames.

(2) Each alternate air intake must be located in a sheltered position and may not open within the cowling if the emergence of backfire flames will result in a hazard.

(3) The supplying of air to the engine through the alternate air intake system may not result in a loss of excessive power in addition to the power loss due to the rise in air temperature.

(4) Each automatic alternate air door must have an override means accessible to the flight crew.

(5) Each automatic alternate air door must have a means to indicate to the flight crew when it is not closed.

(c) For turbine engine powered aeroplanes:

(1) There must be means to prevent hazardous quantities of fuel leakage or overflow from drains, vents, or other components of flammable fluid systems from entering the engine or auxiliary power unit and their accessories intake system; and

(2) The aeroplane must be designed to prevent water or slush on the runway, taxiway, or other airport operating surfaces from being directed into the engine or auxiliary power unit air intake ducts in hazardous quantities. The air intake ducts must be located or protected so as to minimize the hazard of ingestion of foreign matter during takeoff, landing, and taxiing.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1093 *Induction System Icing Protection*

(a) *Reciprocating engines.* Each reciprocating engine air induction system must have means to prevent and eliminate icing. Unless this is done by other means, it must be shown that, in air free of visible moisture at a temperature of 30°F.:

(1) Each aeroplane with sea level engines using conventional venturi carburetors has a preheater that can provide a heat rise of 90° F. with the engines at 75 percent of maximum continuous power;

(2) Each aeroplane with altitude engines using conventional venturi carburetors has a preheater than can provide a heat rise of 120° F. with the engines at 75 percent of maximum continuous power;

(3) Each aeroplane with altitude engines using carburetors tending to prevent icing has a preheater that, with the engines at 60 percent of maximum continuous power, can provide a heat rise of:

(i) 100° F; or

(ii) 40° F, if a fluid de-icing system meeting the requirements of 523.1095 through 523.1099 is installed;

(4) Each aeroplane with sea level engine(s) using a fuel metering device tending to prevent icing has a sheltered alternate source of air with a preheat of not less than 60°F with the engines at 75 percent of maximum continuous power;

(5) Each aeroplane with sea level or altitude engine(s) using fuel injection systems having metering components on which impact ice may accumulate has a preheater capable of providing a heat rise of 75°F when the engine is operating at 75 percent of its maximum continuous power; and

(6) Each aeroplane with sea level or altitude engine(s) using fuel injection systems not having fuel metering components projecting into the airstream on which ice may form, and introducing fuel into the air induction system downstream of any components or other obstruction on which ice produced by fuel evaporation may form, has a sheltered alternate source of air with a preheat of not less than 60°F with the engines at 75 percent of maximum continuous power.

(b) Turbine engines.

(1) Each turbine engine and its air inlet system must operate throughout the flight power range of the engine (including idling), without the accumulation of ice on engine or inlet system components that would adversely affect engine operation or cause a serious loss of power or thrust:

(i) Under the icing conditions specified in appendix C of Chapter 525 of this manual; and

(ii) In snow, both falling and blowing, within the limitations established for the aeroplane for such operation.

(2) Each turbine engine must idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between 15° and 30°F (between -9° and -1°C) and has a liquid water content not less than 0.3 grams per cubic metre in the form of drops having a mean effective diameter not less than 20 microns, followed by momentary operation at takeoff power or thrust. During the 30 minutes of idle operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Minister.

(c) *Reciprocating Engines With Superchargers.* For aeroplanes with reciprocating engines having superchargers to pressurise the air before it enters the fuel metering device, the heat rise in the air caused by that supercharging at any altitude may be utilized in determining compliance with paragraph (a) of this section if the heat rise utilized is that which will be available, automatically, for the applicable altitudes and operating condition because of supercharging.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1095 *Carburetor De-icing Fluid Flow Rate*

(a) If a carburetor de-icing fluid system is used, it must be able to simultaneously supply each engine with a rate of fluid flow, expressed in pounds per hour, of not less than 2.5 times the square root of the maximum continuous power of the engine.

(b) The fluid must be introduced into the air induction system:

(1) Close to, and upstream of, the carburetor; and

(2) So that it is equally distributed over the entire cross section of the induction system air passages.

523.1097 *Carburetor De-icing Fluid System Capacity*

(a) The capacity of each carburetor de-icing fluid system:

(1) May not be less than the greater of:

(i) That required to provide fluid at the rate specified in 523.1095 for a time equal to three percent of the maximum endurance of the aeroplane; or

(ii) 20 minutes at that flow rate; and

(2) Need not exceed that required for two hours of operation.

(b) If the available preheat exceeds 50°F. but is less than 100° F., the capacity of the system may be decreased in proportion to the heat rise available in excess of 50° F.

523.1099 *Carburetor De-icing Fluid System Detail Design*

Each carburetor de-icing fluid system must meet the applicable requirements for the design of a fuel system, except as specified in 523.1095 and 523.1097.

523.1101 *Induction Air Preheater Design*

Each exhaust-heated, induction air preheater must be designed and constructed to:

(a) Ensure ventilation of the preheater when the induction air preheater is not being used during engine operation;

(b) Allow inspection of the exhaust manifold parts that it surrounds; and

(c) Allow inspection of critical parts of the preheater itself.

(Change 523-4 (96-09-01))

523.1103 *Induction System Ducts*

(a) Each induction system duct must have a drain to prevent the accumulation of fuel or moisture in the normal ground and flight attitudes. No drain may discharge where it will cause a fire hazard.

(b) Each duct connected to components between which relative motion could exist must have means for flexibility.

(c) Each flexible induction system duct must be capable of withstanding the effects of temperature extremes, fuel, oil, water, and solvents to which it is expected to be exposed in service and maintenance without hazardous deterioration or delamination.

(d) For reciprocating engine installations, each induction system duct must be:

(1) Strong enough to prevent induction system failures resulting from normal backfire conditions; and

(2) Fire resistant in any compartment for which a fire extinguishing system is required.

(e) Each inlet system duct for an auxiliary power unit must be:

(1) Fireproof within the auxiliary power unit compartment;

(2) Fireproof for a sufficient distance upstream of the auxiliary power unit compartment to prevent hot gas reverse flow from burning through the duct and entering any other compartment of the aeroplane in which a hazard would be created by the entry of the hot gases;

(3) Constructed of materials suitable to the environmental conditions expected in service, except in those areas requiring fireproof or fire resistant materials; and

(4) Constructed of materials that will not absorb or trap hazardous quantities of flammable fluids that could be ignited by a surge or reverse-flow condition.

(f) Induction system ducts that supply air to a cabin pressurization system must be suitably constructed of material that will not produce hazardous quantities of toxic gases or isolated to prevent hazardous quantities of toxic gases from entering the cabin during a powerplant fire.

(Change 523-3 (92-01-02))
(Change 523-4 (96-09-01))

523.1105 *Induction System Screens*

If induction system screens are used:

(a) Each screen must be upstream of the carburetor or fuel injection system.

(b) No screen may be in any part of the induction system that is the only passage through which air can reach the engine, unless:

(1) The available preheat is at least 100° F.; and

(2) The screen can be de-iced by heated air;

(c) No screen may be de-iced by alcohol alone; and

(d) It must be impossible for fuel to strike any screen.

(Change 523-5)

523.1107 *Induction System Filters*

If an air filter is used to protect the engine against foreign material particles in the induction air supply:

(a) Each air filter must be capable of withstanding the effects of temperature extremes, rain, fuel, oil, and solvents to which it is expected to be exposed in service and maintenance; and

(b) Each air filter shall have a design feature to prevent material separated from the filter media from interfering with proper fuel metering operation.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1109 *Turbocharger Bleed Air System*

The following applies to turbo-charged bleed air systems used for cabin pressurization:

(a) The cabin air system may not be subject to hazardous contamination following any probable failure of the turbocharger or its lubrication system.

(b) The turbocharger supply air must be taken from a source where it cannot be contaminated by harmful or hazardous gases or vapours following any probable failure or malfunction of the engine exhaust, hydraulic, fuel, or oil system.

(Change 523-3 (92-01-02))

523.1111 *Turbine Engine Bleed Air System*

For turbine engine bleed air systems, the following apply:

(a) No hazard may result if duct rupture or failure occurs anywhere between the engine port and the aeroplane unit served by the bleed air.

(b) The effect on aeroplane and engine performance of using maximum bleed air must be established.

(c) Hazardous contamination of cabin air systems may not result from failures of the engine lubricating system.

Exhaust System

523.1121 *General*

For powerplant and auxiliary power unit installations, the following apply:

(a) Each exhaust system must ensure safe disposal of exhaust gases without fire hazard or carbon monoxide contamination in any personnel compartment.

(b) Each exhaust system part with a surface hot enough to ignite flammable fluids or vapours must be located or shielded so that leakage from any system carrying flammable fluids or vapours will not result in a fire caused by impingement of the fluids or vapours on any part of the exhaust system including shields for the exhaust system.

(c) Each exhaust system must be separated by fireproof shields from adjacent flammable parts of the aeroplane that are outside of the engine and auxiliary power unit compartments.

(d) No exhaust gases may discharge dangerously near any fuel or oil system drain.

(e) No exhaust gases may be discharged where they will cause a glare seriously affecting pilot vision at night.

(f) Each exhaust system component must be ventilated to prevent points of excessively high temperature.

(g) If significant traps exists, each turbine engine and auxiliary power unit exhaust system must have drains discharging clear of the aeroplane, in any normal ground and flight attitude, to prevent fuel accumulation after the failure of an attempted engine or auxiliary power unit start.

(h) Each exhaust heat exchanger must incorporate means to prevent blockage of the exhaust port after any internal heat exchanger failure.

(i) For the purpose of compliance with 523.603, the failure of any part of the exhaust system will be considered to adversely affect safety.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1123 *Exhaust System*

(a) Each exhaust system must be fireproof and corrosion-resistant, and must have means to prevent failure due to expansion by operating temperatures.

(b) Each exhaust system must be supported to withstand the vibration and inertia loads to which it may be subjected in operation.

(c) Parts of the system connected to components between which relative motion could exist must have means for flexibility.

(Change 523-4 (96-09-01))

523.1125 *Exhaust Heat Exchangers*

For reciprocating engine powered aeroplanes the following apply:

(a) Each exhaust heat exchanger must be constructed and installed to withstand the vibration, inertia, and other loads that it may be subjected to in normal operation. In addition:

(1) Each exchanger must be suitable for continued operation at high temperatures and resistant to corrosion from exhaust gases;

(2) There must be means for inspection of critical parts of each exchanger; and

(3) Each exchanger must have cooling provisions wherever it is subject to contact with exhaust gases.

(b) Each heat exchanger used for heating ventilating air must be constructed so that exhaust gases may not enter the ventilating air.

Powerplant Controls and Accessories

523.1141 Powerplant Controls: General

(a) Powerplant controls must be located and arranged under 523.777 and marked under 523.1555 (a).

(b) Each flexible control must be shown to be suitable for the particular application.

(c) Each control must be able to maintain any necessary position without:

(1) Constant attention by flight crew members; or

(2) Tendency to creep due to control loads or vibration.

(d) Each control must be able to withstand operating loads without failure or excessive deflection.

(e) For turbine engine powered aeroplanes, no single failure or malfunction, or probable combination thereof, in any powerplant control system may cause the failure of any powerplant function necessary for safety.

(f) The portion of each powerplant control located in the engine compartment that is required to be operated in the event of fire must be at least fire resistant.

(g) Powerplant valve controls located in the cockpit must have:

(1) For manual valves, positive stops or in the case of fuel valves suitable index provisions, in the open and closed position; and

(2) For power-assisted valves, a means to indicate to the flight crew when the valve:

(i) Is in the fully open or fully closed position; or

(ii) Is moving between the fully open and fully closed position.

(Change 523-5)

523.1142 *Auxiliary Power Unit Controls*

Means must be provided on the flight deck for the starting, stopping, monitoring, and emergency shutdown of each installed auxiliary power unit.

(Change 523-4 (96-09-01))

523.1143 *Engine Controls*

(a) There must be a separate power or thrust control for each engine and a separate control for each supercharger that requires a control.

(b) Power, thrust, and supercharger controls must be arranged to allow:

(1) Separate control of each engine and each supercharger; and

(2) Simultaneous control of all engines and all superchargers.

(c) Each power, thrust, or supercharger control must give a positive and immediate responsive means of controlling its engine or supercharger.

(d) The power, thrust, or supercharger controls for each engine or supercharger must be independent of those for every other engine or supercharger.

(e) For each fluid injection (other than fuel) system and its controls not provided and approved as part of the engine, the applicant must show that the flow of the injection fluid is adequately controlled.

(f) If a power, thrust, or a fuel control (other than a mixture control) incorporates a fuel shut-off feature, the control must have a means to prevent the inadvertent movement of the control into the off position. The means must:

(1) Have a positive lock or stop at the idle position; and

(2) Require a separate and distinct operation to place the control in the shut-off position.

(g) For reciprocating single-engine aeroplanes, each power or thrust control must be designed so that if the control separates at the engine fuel metering device, the aeroplane is capable of continued safe flight and landing.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1145 *Ignition Switches*

(a) Ignition switches must control and shut off each ignition circuit on each engine.

(b) There must be means to quickly shut off all ignition on multi-engine aeroplanes by the groupings of switches or by a master ignition control.

(c) Each group of ignition switches, except ignition switches for turbine engines for which continuous ignition is not required, and each master ignition control must have a means to prevent its inadvertent operation.

(Change 523-4 (96-09-01))

523.1147 *Mixture Controls*

If there are mixture controls, each engine must have a separate control, and each mixture control must have guards or must be shaped or arranged to prevent confusion by feel with other controls.

(a) (1) The controls must be grouped and arranged to allow:

(i) Separate control of each engine; and

(ii) Simultaneous control of all engines.

(2) The controls must require a separate and distinct operation to move the control toward lean or shut-off position.

(b) For reciprocating single-engine aeroplanes, each manual engine mixture control must be designed so that, if the control separates at the engine fuel metering device, the aeroplane is capable of continued safe flight and landing.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))

523.1149 *Propeller Speed and Pitch Controls*

(a) If there are propeller speed or pitch controls, they must be grouped and arranged to allow:

(1) Separate control of each propeller; and

(2) Simultaneous control of all propellers.

(b) The controls must allow ready synchronisation of all propellers on multi-engine aeroplanes.

523.1153 *Propeller Feathering Controls.*

If there are propeller feathering controls installed, it must be possible to feather each propeller separately. Each control must have a means to prevent inadvertent operation.

(Change 523-5)

523.1155 *Turbine Engine Reverse Thrust and Propeller Pitch Settings Below the Flight Regime*

For turbine engine installations, each control for reverse thrust and for propeller pitch settings below the flight regime must have means to prevent its inadvertent operation. The means must have a positive lock or stop at the flight idle position and must require a separate and distinct operation by the crew to displace the control from the flight regime (forward thrust regime for turbojet powered aeroplanes).

523.1157 *Carburetor Air Temperature Controls*

There must be a separate carburetor air temperature control for each engine.

523.1163 *Powerplant Accessories*

(a) Each engine mounted accessory must:

(1) Be approved for mounting on the engine involved and use the provisions on the engines for mounting; or

(2) Have torque limiting means on all accessory drives in order to prevent the torque limits established for those drives from being exceeded; and

(3) In addition to paragraphs (a)(1) or (a)(2) of this section, be sealed to prevent contamination of the engine oil system and the accessory system.

(b) Electrical equipment subject to arcing or sparking must be installed to minimize the probability of contact with any flammable fluids or vapours that might be present in a free state.

(c) Each generator rated at or more than 6 kilowatts must be designed and installed to minimize the probability of a fire hazard in the event it malfunctions.

(d) If the continued rotation of any accessory remotely driven by the engine is hazardous when malfunctioning occurs, a means to prevent rotation without interfering with the continued operation of the engine must be provided.

(e) Each accessory driven by a gearbox that is not approved as part of the powerplant driving the gearbox must:

(1) Have torque limiting means to prevent the torque limits established for the affected drive from being exceeded;

(2) Use the provisions on the gearbox for mounting; and

(3) Be sealed to prevent contamination of the gearbox oil system and the accessory system.

(Change 523-3 (92-01-02))

523.1165 *Engine Ignition Systems*

(a) Each battery ignition system must be supplemented by a generator that is automatically available as an alternate source of electrical energy to allow continued engine operation if any battery becomes depleted.

(b) The capacity of batteries and generators must be large enough to meet the simultaneous demands of the engine ignition system and the greatest demands of any electrical system components that draw from the same source.

(c) The design of the engine ignition system must account for:

(1) The condition of an inoperative generator;

(2) The condition of a completely depleted battery with the generator running at its normal operating speed; and

(3) The condition of a completely depleted battery with the generator operating at idling speed if there is only one battery.

(d) There must be means to warn appropriate crew members if malfunctioning of any part of the electrical system is causing the continuous discharge of any battery used for engine ignition.

(e) Each turbine engine ignition system must be independent of any electrical circuit that is not used for assisting, controlling, or analysing the operation of that system.

(f) In addition, for commuter category aeroplanes, each turbo propeller ignition system must be an essential electrical load.

(Change 523-1 (88-01-01))

Powerplant Fire Protection

523.1181 *Designated Fire Zones; Regions Included*

Designated fire zones are:

(a) For reciprocating engines:

(1) The power section;

(2) The accessory section;

(3) Any complete powerplant compartment in which there is no isolation between the power section and the accessory section.

(b) For turbine engines:

(1) The compressor and accessory sections;

(2) The combustor, turbine and tailpipe sections that contain lines or components carrying flammable fluids or gases.

(3) Any complete powerplant compartment in which there is no isolation between compressor, accessory, combustor, turbine, and tailpipe sections.

(c) Any auxiliary power unit compartment; and

(d) Any fuel-burning heater, and other combustion equipment installation described in 523.859.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1182 *Nacelle Areas Behind Firewalls*

Components, lines, and fittings, except those subject to the provision of 523.1351 (e), located behind the engine-compartment firewall must be constructed of such materials and located at such distances from the firewall that they will not suffer damage sufficient to endanger the aeroplane if a portion of the engine side of the firewall is subjected to a flame temperature of not less than 2000°F for 15 minutes.

523.1183 *Lines, Fittings and Components*

(a) Except as provided in paragraph (b) of this section, each component, line, and fitting carrying flammable fluids, gas, or air in any area subject to engine fire conditions must be at least fire resistant, except that flammable fluid tanks and supports which are part of and attached to the engine must be fireproof or be enclosed by a fireproof shield unless

damage by fire to any non-fireproof part will not cause leakage or spillage of flammable fluid. Components must be shielded or located so as to safeguard against the ignition of leaking flammable fluid. Flexible hose assemblies (hose and end fittings) must be shown to be suitable for the particular application. An integral oil sump of less than 25 quart capacity on a reciprocating engine need not be fireproof nor be enclosed by a fireproof shield.

(b) Paragraph (a) of this section does not apply to:

(1) Lines, fittings and components which are already approved as part of a type certificated engine; and

(2) Vent and drain lines, and their fittings, whose failures will not result in, or add to, a fire hazard.

(Change 523-5)

523.1189 *Shut-off Means*

(a) For each multi-engine aeroplane the following apply:

(1) Each engine installation must have means to shut off or otherwise prevent hazardous quantities of fuel, oil, de-icing fluid, and other flammable liquids from flowing into, within, or through any engine compartment, except in lines, fittings, and components forming an integral part of an engine.

(2) The closing of the fuel shut-off valve for any engine may not make any fuel unavailable to the remaining engines that would be available to those engines with that valve open.

(3) Operation of any shut-off means may not interfere with the later emergency operation of other equipment such as propeller feathering devices.

(4) Each shut-off must be outside of the engine compartment unless an equal degree of safety is provided with the shut-off inside the compartment.

(5) Not more than one quart of flammable fluid may escape into the engine compartment after engine shut-off. For those installations where the flammable fluid that escapes after shutdown cannot be limited to one quart, it must be demonstrated that this greater amount can be safely contained or drained overboard.

(6) There must be means to guard against inadvertent operations of each shut-off means, and to make it possible for the crew to reopen the shut-off means in flight after it has been closed.

(b) Turbine engine installations need not have an engine oil system shut-off if:

(1) The oil tank is integral with, or mounted on, the engine; and

(2) All oil system components external to the engine are fireproof or located in areas not subject to engine fire conditions.

(c) Power operated valves must have means to indicate to the flight crew when the valve has reached the selected position and must be designed so that the valve will not move from the selected position under vibration conditions likely to exist at the valve location.

(Change 523-4 (96-09-01))

523.1191 *Firewalls*

(a) Each engine, auxiliary power unit, fuel burning heater, and other combustion equipment must be isolated from the rest of the aeroplane by firewalls, shrouds, or equivalent means.

(b) Each firewall or shroud must be constructed so that no hazardous quantity of liquid, gas, or flame can pass from the compartment created by the firewall or shroud to other parts of the aeroplane.

(c) Each opening in the firewall or shroud must be sealed with close fitting, fireproof grommets, bushings, or firewall fittings.

(d) (Removed and Reserved)

(e) Each firewall and shroud must be fireproof and protected against corrosion.

(f) Compliance with the criteria for fireproof materials or components must be shown as follows:

(1) The flame to which the materials or components are subjected must be $2000 \pm 150^{O}F$.

(2) Sheet materials approximately 10 inches square must be subjected to the flame from a suitable burner.

(3) The flame must be large enough to maintain the required test temperature over an area approximately five inches square.

(g) Firewall materials and fittings must resist flame penetration for at least 15 minutes.

(h) The following materials may be used in firewalls or shrouds without being tested as required by this section:

(1) Stainless steel sheet, 0.015 inch thick.

(2) Mild steel sheet, (coated with aluminum or otherwise protected against corrosion) 0.018 inch thick.

(3) Terne plate, 0.018 inch thick.

(4) Monel metal, 0.018 inch thick.

(5) Steel or copper base alloy firewall fittings.

(6) Titanium sheet, 0.016 inch thick.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1192 *Engine Accessory Compartment Diaphragm*

For air-cooled radial engines, the engine power section and all portions of the exhaust system must be isolated from the engine accessory compartment by a diaphragm that meets the firewall requirements of 523.1191.

523.1193 *Cowling and Nacelle*

(a) Each cowling must be constructed and supported so that it can resist any vibration, inertia, and air loads to which it may be subjected in operation.

(b) There must be means for rapid and complete drainage of each part of the cowling in the normal ground and flight attitudes. Drain operation may be shown by test, analysis, or both, to ensure that under normal aerodynamic pressure distribution expected in service each drain will operate as designed. No drain may discharge where it will cause a fire hazard.

(c) Cowling must be at least fire resistant.

(d) Each part behind an opening in the engine compartment cowling must be at least fire resistant for a distance of at least 24 inches aft of the opening.

(e) Each part of the cowling subjected to high temperatures due to its nearness to exhaust system ports or exhaust gas impingement, must be fireproof.

(f) Each nacelle of a multi-engine aeroplane with supercharged engines must be designed and constructed so that with the landing gear retracted, a fire in the engine compartment will not burn through a cowling or nacelle and enter a nacelle area other than the engine compartment.

(g) In addition, for commuter category aeroplanes, the aeroplane must be designed so that no fire originating in any engine compartment can enter, either through openings or by burn through, any other region where it would create additional hazards.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))

523.1195 *Fire Extinguishing Systems*

(a) For commuter category aeroplanes, fire extinguishing systems must be installed and compliance shown with the following:

(1) Except for combustor, turbine, and tailpipe sections of turbine-engine installations that contain lines or components carrying flammable fluids or gases for which a fire originating in these sections is shown to be controllable, a fire extinguisher system must serve each engine compartment.

(2) The fire extinguishing system, the quantity of the extinguishing agent, the rate of discharge, and the discharge distribution must be adequate to extinguish fires. An individual "one shot" system may be used.

(3) The fire extinguishing system for a nacelle must be able to simultaneously protect each compartment of the nacelle for which protection is provided.

(b) If an auxiliary power unit is installed in any aeroplane approved to this chapter, that auxiliary power unit compartment must be served by a fire extinguishing system meeting the requirements of paragraph (a)(2) of this section.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))

523.1197 *Fire Extinguishing Agents*

For commuter category aeroplanes, the following applies:

(a) Fire extinguishing agents must:

(1) Be capable of extinguishing flames emanating from any burning of fluids or other combustible materials in the area protected by the fire extinguishing system; and

(2) Have thermal stability over the temperature range likely to be experienced in the compartment in which they are stored.

(b) If any toxic extinguishing agent is used, provisions must be made to prevent harmful concentrations of fluid or fluid vapours (from leakage during normal operation of the aeroplane or as a result of discharging the fire extinguisher on the ground or in flight) from entering any personnel compartment, even though a defect may exist in the extinguishing system. This must be shown by test except for built-in carbon dioxide fuselage compartment fire extinguishing systems for which:

(1) Five pounds or less or carbon dioxide will be discharged, under established fire control procedures, into any fuselage compartment; or

(2) Protective breathing equipment is available for each flight crewmember on flight deck duty.

(Change 523-1 (88-01-01))

523.1199 *Extinguishing Agent Containers*

For commuter category aeroplanes, the following applies:

(a) Each extinguishing agent container must have a pressure relief to prevent bursting of the container by excessive internal pressures.

(b) The discharge end of each discharge line from a pressure relief connection must be located so that discharge of the fire extinguishing agent would not damage the aeroplane. The line must also be located or protected to prevent clogging caused by ice or other foreign matter.

(c) A means must be provided for each fire extinguishing agent container to indicate that the container has discharged or that the charging pressure is below the established minimum necessary for proper functioning.

(d) The temperature of each container must be maintained, under intended operating conditions, to prevent the pressure in the container from

(1) Falling below that necessary to provide an adequate rate of discharge; or

(2) Rising high enough to cause premature discharge.

(e) If a pyrotechnic capsule is used to discharge the extinguishing agent, each container must be installed so that temperature conditions will not cause hazardous deterioration of the pyrotechnic capsule.

(Change 523-1 (88-01-01))

523.1201 *Fire Extinguishing System Materials*

For commuter category aeroplanes, the following apply:

(a) No material in any fire extinguishing system may react chemically with any extinguishing agent so as to create a hazard.

(b) Each system component in an engine compartment must be fireproof.

(Change 523-1 (88-01-01))

523.1203 *Fire Detector System*

(a) There must be means that ensure the prompt detection of a fire in:

(1) An engine compartment of:

(i) Multi-engine turbine powered aeroplanes;

(ii) Multi-engine reciprocating engine powered aeroplanes incorporating turbochargers;

(iii) Aeroplanes with engine(s) located where they are not readily visible from the cockpit; and

(iv) All commuter category aeroplanes.

(2) The auxiliary power unit compartment of any aeroplane incorporating an auxiliary power unit.

(b) Each fire detector must be constructed and installed to withstand the vibration, inertia, and other loads to which it may be subjected in operation.

(c) No fire detector may be affected by any oil, water, other fluids, or fumes that might be present.

(d) There must be means to allow the crew to check, in flight, the functioning of each fire detector electric circuit.

(e) Wiring and other components of each fire detector system in a designated fire zone must be at least fire resistant.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

SUBCHAPTER F

Equipment - General

523.1301 *Function and Installation*

Each item of installed equipment must:

(a) Be of a kind and design appropriate to its intended function;

(b) Be labelled as to its identification, function, or operating limitations, or any applicable combination of these factors;

(c) Be installed according to limitations specified for that equipment; and

(d) Function properly when installed.

523.1301-1 *Aeroplane Operation After Ground Cold Soak*

For commuter category aeroplanes, having a maximum certificated takeoff weight greater than 5700 kg (12,566 pounds) or more than 9 passenger seats, excluding pilot seats, substantiation of satisfactory operation of the aeroplane as a total system, by cold weather testing or by documented evidence of satisfactory operation at low temperature, is required after the aeroplane has experienced a prolonged exposure to ground ambient temperatures equal to or less than -35°C unless an alternative minimum ground ambient temperature has been proposed by the applicant and accepted by the Minister.

FAR: No corresponding section.

(Change 523-1 (88-01-01))

523.1303 *Flight and Navigation Instruments*

The following are the minimum required flight and navigation instruments:

(a) An airspeed indicator.

(b) An altimeter.

(c) A direction indicator (non-stabilized magnetic compass).

(d) For reciprocating engine-powered aeroplanes of more than 6,000 pounds maximum weight and turbine engine powered aeroplanes, a free air temperature indicator or an air temperature indicator which provides indications that are convertible to free-air.

(e) A speed warning device for:

(1) Turbine engine powered aeroplanes; and

(2) Other aeroplanes for which V_{MO}/M_{MO} and V_D/M_D are established under 523.335 (b)(4) and 523.1505 (c) if V_{MO}/M_{MO} is greater than 0.8 V_D/M_D.

The speed warning device must give effective aural warning (differing distinctively from aural warnings used for other purposes) to the pilots whenever the speed exceeds V_{MO} plus 6 knots or M_{MO} + 0.01. The upper limit of the production tolerance for the warning device may not exceed the prescribed warning speed. The lower limit of the warning device must be set to minimize nuisance warning.

(f) When an attitude display is installed, the instrument design must not provide any means, accessible to the flight crew, of adjusting the relative positions of the attitude reference symbol and the horizon line beyond that necessary for parallax correction.

(g) In addition, for commuter category aeroplanes:

(1) If airspeed limitations vary with altitude, the airspeed indicator must have a maximum allowable airspeed indicator showing the variation of V_{MO} with altitude.

(2) The altimeter must be a sensitive type.

(3) Having a passenger seating configuration of 10 or more, excluding the pilot's seats and that are approved for IFR operations, a third attitude instrument must be provided that:

(i) Is powered from a source independent of the electrical generating system;

(ii) Continues reliable operation for a minimum of 30 minutes after total failure of the electrical generating system;

(iii) Operates independently of any other attitude indicating system;

(iv) Is operative without selection after total failure of the electrical generating system;

(v) Is located on the instrument panel in a position acceptable to the Minister that will make it plainly visible to and usable by any pilot at the pilot's station; and

(vi) Is appropriately lighted during all phases of operation.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

523.1305 *Powerplant Instruments*

The following are required powerplant instruments:

(a) For all aeroplanes.

(1) A fuel quantity indicator for each fuel tank, installed in accordance with 523.1337(b).

(2) An oil pressure indicator for each engine.

(3) An oil temperature indicator for each engine.

(4) An oil quantity measuring device for each oil tank which meets the requirements of 523.1337(d).

(5) A fire warning means for those aeroplanes required to comply with 523.1203.

(b) For reciprocating engine-powered aeroplanes. In addition to the powerplant instruments required by paragraph (a) of this section, the following powerplant instruments are required:

(1) An induction system air temperature indicator for each engine equipped with a preheater and having induction air temperature limitations that can be exceeded with preheat.

(2) A tachometer indicator for each engine.

(3) A cylinder head temperature indicator for:

(i) Each air-cooled engine with cowl flaps;

(ii) Removed and Reserved;

(iii) Each commuter category aeroplane.

(4) For each pump-fed engine, a means:

(i) That continuously indicates, to the pilot, the fuel pressure or fuel flow; or

(ii) That continuously monitors the fuel system and warns the pilot of any fuel flow trend that could lead to engine failure.

(5) A manifold pressure indicator for each altitude engine and for each engine with a controllable propeller.

(6) For each turbocharger installation:

(i) If limitations are established for either carburettor (or manifold) air inlet temperature or exhaust gas or turbocharger turbine inlet temperature, indicators must be furnished for each temperature for which the limitation is established unless it is shown that the limitation will not be exceeded in all intended operations.

(ii) If its oil system is separate from the engine oil system, oil pressure and oil temperature indicators must be provided.

(7) A coolant temperature indicator for each liquid-cooled engine.

(c) For turbine engine-powered aeroplanes. In addition to the powerplant instruments required by paragraph (a) of this section, the following powerplant instruments are required:

(1) A gas temperature indicator for each engine.

(2) A fuel flow meter indicator for each engine.

(3) A fuel low pressure warning means for each engine.

(4) A fuel low level warning means for any fuel tank that should not be depleted of fuel in normal operations.

(5) A tachometer indicator (to indicate the speed of the rotors with established limiting speeds) for each engine.

(6) An oil low pressure warning means for each engine.

(7) An indicating means to indicate the functioning of the powerplant ice protection system for each engine.

(8) For each engine, an indicating means for the fuel strainer or filter required by 523.997 to indicate the occurrence of contamination of the strainer or filter before it reaches the capacity established in accordance with 523.997(d).

(9) For each engine, a warning means for the oil strainer or filter required by 523.1019, if it has no bypass, to warn the pilot of the occurrence of contamination of the strainer or filter screen before it reaches the capacity established in accordance with 523.1019(a)(5).

(10) An indicating means to indicate the functioning of any heater used to prevent ice clogging of fuel system components.

(d) For turbojet/turbofan engine-powered aeroplanes. In addition to the powerplant instruments required by paragraphs (a) and (c) of this section, the following powerplant instruments are required:

(1) For each engine, an indicator to indicate thrust or to indicate a parameter that can be related to thrust, including a free air temperature indicator if needed for this purpose.

(2) For each engine, a position indicating means to indicate to the flight crew when the thrust reverser, if installed, is in the reverse thrust position.

(e) For turbo propeller-powered aeroplanes. In addition to the powerplant instruments required by paragraphs (a) and (c) of this section, the following powerplant instruments are required:

(1) A torque indicator for each engine.

(2) A position indicating means to indicate to the flight crew when the propeller blade angle is below the flight low pitch position, for each propeller, unless it can be shown that such occurrence is highly improbable.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

523.1307 *Miscellaneous Equipment*

The equipment necessary for an aeroplane to operate at the maximum operating altitude and in the kinds of operations and meteorological conditions for which certification is requested and is approved in accordance with 523.1559 must be included in the type design.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1308 *High-intensity Radiated Fields (HIRF) Protection*
(amended 2008/10/30)

(a) Except as provided in paragraph (d) of this section, each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the aeroplane shall be designed and installed so that:
(amended 2008/10/30)

(1) The function is not adversely affected during and after the time the aeroplane is exposed to HIRF environment I, as described in Appendix J of this chapter;
(amended 2008/10/30)

(2) The system automatically recovers normal operation of that function, in a timely manner, after the aeroplane is exposed to HIRF environment I, as described in Appendix J of this chapter, unless the system's recovery conflicts with other operational or functional requirements of the system; and
(amended 2008/10/30)

(3) The system is not adversely affected during and after the time the aeroplane is exposed to HIRF environment II, as described in Appendix J of this chapter.
(amended 2008/10/30)

(b) Each electrical and electronic system that performs a function whose failure would significantly reduce the capability of the aeroplane or the ability of the flight crew to respond to an adverse operating condition shall be designed and installed so the system is not adversely affected when the equipment providing the function is exposed to equipment HIRF test level 1 or 2, as described in Appendix J of this chapter.
(amended 2008/10/30)

(c) Each electrical and electronic system that performs a function whose failure would reduce the capability of the aeroplane or the ability of the flight crew to respond to an adverse operating condition shall be designed and installed so the system is not adversely affected when the equipment providing the function is exposed to equipment HIRF test level 3, as described in Appendix J of this chapter.
(amended 2008/10/30)

(d) Before December 1, 2012, an electrical or electronic system that performs a function whose failure would prevent the continued safe flight and landing of an aeroplane may be designed and installed without meeting the provisions of paragraph (a) provided:
(amended 2008/10/30)

(1) The system has previously been shown to comply with Special Conditions - Airworthiness for HIRF, specified by the Minister pursuant to Part V of the *Canadian Aviation Regulations* (CARs);
(amended 2008/10/30)

(2) The HIRF immunity characteristics of the system have not changed since compliance with the special conditions was demonstrated; and
(amended 2008/10/30)

(3) The data used to demonstrate compliance with the Special Conditions – Airworthiness for HIRF is provided.
(amended 2008/10/30)

523.1309 *Equipment, Systems, and Installations*

(a) Each item of equipment, each system, and each installation:

(1) When performing its intended function, may not adversely affect the response, operation, or accuracy of any:

(i) Equipment essential to safe operation; or

(ii) Other equipment unless there is a means to inform the pilot of the effect.

(2) In a single-engine aeroplane, must be designed to minimize hazards to the aeroplane in the event of a probable malfunction or failure.

(3) In a multi-engine aeroplane, must be designed to prevent hazards to the aeroplane in the event of a probable malfunction or failure.

(4) In a commuter category aeroplane, must be designed to safeguard against hazards to the aeroplane in the event of their malfunction or failure.

(b) The design of each item of equipment, each system, and each installation must be examined separately and in relationship to other aeroplane systems and installations to determine if the aeroplane is dependent upon its function for continued safe flight and landing and, for aeroplanes not limited to VFR conditions, if failure of a system would significantly reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions. Each item of equipment, each system, and each installation identified by this examination as one upon which the aeroplane is dependent for proper functioning to ensure continued safe flight and landing, or whose failure would significantly reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions, must be designed to comply with the following additional requirements:

(1) It must perform its intended function under any foreseeable operating condition.

(2) When systems and associated components are considered separately and in relation to other systems:

(i) The occurrence of any failure condition that would prevent the continued safe flight and landing of the aeroplane must be extremely improbable; and

(ii) The occurrence of any other failure condition that would significantly reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions must be improbable.

(3) Warning information must be provided to alert the crew to unsafe system operating conditions and to enable them to make appropriate corrective action. Systems, controls, and associated monitoring and warning means must be designed to minimize crew errors that could create additional hazards.

(4) Compliance with the requirements of paragraph (b)(2) of this section may be shown by analysis and where necessary, by appropriate ground, flight, or simulator tests. The analysis must consider:

(i) Possible modes of failure, including malfunctions and damage from external sources;

(ii) The probability of multiple failures, and the probability of undetected faults.;

(iii) The resulting effects on the aeroplane and occupants, considering the stage of flight and operating conditions; and

(iv) The crew warning cues, corrective action required, and the crew's capability of determining faults.

(c) Each item of equipment, each system, and each installation whose functioning is required by this manual and that requires a power supply is an "essential load" on the power supply. The power sources and the system must be able to supply the following power loads in probable operating combinations and for probable durations:

(1) Loads connected to the power distribution system with the system functioning normally.

(2) Essential loads after failure of:

(i) Any one engine on two-engine aeroplanes; or

(ii) Any two engines on an aeroplane with three or more engines; or

(iii) Any power converter or energy storage device.

(3) Essential loads for which an alternate source of power is required, as applicable, by any applicable operating rules after any failure or malfunction in any one power supply system, distribution system, or other utilisation system.

(d) In determining compliance with paragraph (c)(2) of this section, the power loads may be assumed to be reduced under a monitoring procedure consistent with safety in the kinds of operations authorised. Loads not required in controlled flight need not be considered for the two-engine-inoperative condition on aeroplanes with three or more engines.

(e) In showing compliance with this section with regard to the electrical power system and to equipment design and installation., critical environmental and atmospheric conditions, including radio frequency energy and the effects (both direct and indirect) of lightning strikes, must be considered. For electrical generation, distribution, and utilisation equipment required by or used in complying with this manual, the ability to provide continuous, safe service under foreseeable environmental conditions may be shown by environmental tests, design analysis, or reference to previous comparable service experience on other aeroplanes.

(f) As used in this section, "system" refers to all pneumatic systems, fluid systems, electrical systems, mechanical systems, and powerplant systems included in the aeroplane design, except for the following:

(1) Powerplant systems provided as part of the certificated engine.

(2) The flight structure (such as wing, empennage, control surfaces and their systems, the fuselage, engine mounting, and landing gear and their related primary attachments) whose requirements are specific in subchapters C and D of this chapter.

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))
(Change 523-5)

523.1311 *Electronic Display Instrument Systems*

(a) Electronic display indicators, including those with features that make isolation and independence between powerplant instrument systems impractical, must:

(1) Meet the arrangement and visibility requirements of 523.1321.

(2) Be easily legible under all lighting conditions encountered in the cockpit, including direct sunlight, considering the expected electronic display brightness level at the end of an electronic display indicator's useful life. Specific limitations on display system useful life must be contained in the Instructions for Continued Airworthiness required by 523.1529.

(3) Not inhibit the primary display of attitude, airspeed, altitude, or powerplant parameters needed by any pilot to set power within established limitations, in any normal mode of operation.

(4) Not inhibit the primary display of engine parameters needed by any pilot to properly set or monitor powerplant limitations during the engine starting mode of operation.

(5) Have an independent magnetic direction indicator and either an independent secondary mechanical altimeter, airspeed indicator, and attitude instrument or individual electronic display indicators for the altitude, airspeed, and attitude that are independent from the aeroplane's primary electrical power system. These secondary instruments may be installed in panel positions that are displaced from the primary positions specified by 523.1321(d), but must be located where they meet the pilot's visibility requirements of 523.1321(a).

(6) Incorporate sensory cues for the pilot that are equivalent to those in the instrument being replaced by the electronic display indicators.

(7) Incorporate visual displays of instrument markings, required by 523.1541 through 523.1553, or visual displays that alert the pilot to abnormal operational values or approaches to established limitation values, for each parameter required to be displayed by this Chapter.

(b) The electronic display indicators, including their systems and installations, and considering other aeroplane systems, must be designed so that one display of information essential for continued safe flight and landing will remain available to the crew, without need for immediate action by any pilot for continued safe operation, after any single failure or probable combination of failures.

(c) As used in this section, "instrument" includes devices that are physically contained in one unit, and devices that are composed of two or more physically separate units or components connected together (such as a remote indicating gyroscopic direction indicator that includes a magnetic sensing element, a gyroscopic unit, an amplifier, and an indicator connected together). As used in this section, "primary" display refers to the display of a parameter that is located in the instrument panel such that the pilot looks at it first when wanting to view that parameter.

(Change 523-3 (92-01-02))
(Change 523-5)

Instruments: Installation

523.1321 *Arrangement and Visibility*

(a) Each flight, navigation, and powerplant instrument for use by any required pilot during takeoff, initial climb, final approach, and landing must be located so that any pilot seated at the controls can monitor the aeroplane's flight path and these instruments with minimum head and eye movement. The powerplant instruments for these flight conditions are those needed to set power within powerplant limitations.

(b) For each multi-engine aeroplane, identical powerplant instruments must be located so as to prevent confusion as to which engine each instrument relates.

(c) Instrument panel vibration may not damage, or impair the accuracy of, any instrument.

(d) For each aeroplane, the flight instruments required by 523.1303, and, as applicable, by any applicable operating rules, must be grouped on the instrument panel and centred as nearly as practicable about the vertical plane of each required pilot's forward vision. In addition:

(1) The instrument that most effectively indicates the attitude must be on the panel in the top centre position;

(2) The instrument that most effectively indicates airspeed must be adjacent to and directly to the left of the instrument in the top centre position;

(3) The instrument that most effectively indicates altitude must be adjacent to and directly to the right of the instrument in the top centre position;

(4) The instrument that most effectively indicates direction of flight, other than the magnetic direction indicator required by 523.1303 (c), must be adjacent to and directly below the instrument in the top centre position; and

(5) Electronic display indicators may be used for compliance with paragraphs (d)(1) through (d)(4) of this section when such displays comply with requirements in 523.1311.

(e) If a visual indicator is provided to indicate malfunction of an instrument, it must be effective under all probable cockpit lighting conditions.

(Change 523-3 (92-01-02))
(Change 523-5)

523.1322 *Warning, Caution, and Advisory Lights*

If warning, caution, or advisory lights are installed in the cockpit, they must, unless otherwise approved by the Minister, be:

(a) Red, for warning lights (lights indicating a hazard which may require immediate corrective action);

(b) Amber, for caution lights (lights indicating the possible need for future corrective action);

(c) Green, for safe operation lights; and

(d) Any other colour, including white, for lights not described in paragraphs (a) through (c) of this section, provided the colour differs sufficiently from the colours prescribed in paragraphs (a) through (c) of this section to avoid possible confusion.

(e) Effective under all probable cockpit lighting conditions.

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))
(Change 523-4 (96-09-01))

523.1323 *Airspeed Indicating System*

(a) Each airspeed indicating instrument must be calibrated to indicate true airspeed (at sea level with a standard atmosphere) with a minimum practicable instrument calibration error when the corresponding pitot and static pressures are applied.

(b) Each airspeed system must be calibrated in flight to determine the system error. The system error, including position error, but excluding the airspeed indicator instrument calibration error, may not exceed three percent of the calibrated airspeed or five knots, whichever is greater, throughout the following speed ranges:

(1) 1.3 V_{S1} to V_{MO}/M_{MO} or V_{NE}, whichever is appropriate with flaps retracted.

(2) 1.3 V_{S1} to V_{FE} with flaps extended.

(c) The design and installation of each airspeed indicating system must provide positive drainage of moisture from the pitot static plumbing.

(d) If certification for instrument flight rules or flight in icing conditions is requested, each airspeed system must have a heated pitot tube or an equivalent means of preventing malfunction due to icing.

(e) In addition, for commuter category aeroplanes, the airspeed indicating system must be calibrated to determine the system error during the accelerate-take-off ground run. The ground run calibration must be obtained between 0.8 of the minimum value of V_1, and 1.2

times the maximum value of V_1 considering the approved ranges of altitude and weight. The ground run calibration must be determined assuming an engine failure at the minimum value of V_1.

(f) For commuter category aeroplanes, where duplicate airspeed indicators are required, their respective pitot tubes must be far enough apart to avoid damage to both tubes in a collision with a bird.

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))
(Change 523-5)

523.1325 *Static Pressure System*

(a) Each instrument provided with static pressure case connections must be so vented that the influence of aeroplane speed, the opening and closing of windows, airflow variations, moisture, or other foreign matter will least affect the accuracy of the instruments except as noted in paragraph (b)(3) of this section.

(b) If a static pressure system is necessary for the functioning of instruments, systems, or devices, it must comply with the provisions of subparagraphs (1) through (3) of this paragraph.

(1) The design and installation of a static pressure system must be such that:

(i) Positive drainage of moisture is provided;

(ii) Chafing of the tubing, and excessive distortion or restriction at bends in the tubing, is avoided; and

(iii) The materials used are durable, suitable for the purpose intended, and protected against corrosion.

(2) A proof test must be conducted to demonstrate the integrity of the static pressure system in the following manner:

(i) Unpressurized aeroplanes. Evacuate the static pressure system to a pressure differential of approximately 1 inch of mercury or a reading on the altimeter, 1,000 feet above the aircraft elevation at the time of the test. Without additional pumping for a period of 1 minute, the loss of indicated altitude must not exceed 100 feet on the altimeter.

(ii) Pressurised aeroplanes. Evacuate the static pressure system until a pressure differential equivalent to the maximum cabin pressure differential for which the aeroplane is type certificated is achieved. Without additional pumping for a period of 1 minute, the loss of indicated altitude must not exceed 2 percent of the equivalent altitude of the maximum cabin differential pressure or 100 feet, whichever is greater.

(3) If a static pressure system is provided for any instrument, device, or system required by any applicable operating rule, each static pressure port must be designed or located in such a manner that the correlation between air pressure in the static pressure

system and true ambient atmospheric static pressure is not altered when the aeroplane encounters icing conditions. An anti-icing means or an alternate source of static pressure may be used in showing compliance with this requirement. If the reading of the altimeter, when on the alternate static pressure system differs from the reading of the altimeter when on the primary static system by more than 50 feet, a correlation card must be provided for the alternate static system.

(c) Except as provided in paragraph (d) of this section, if the static pressure system incorporates both a primary and an alternate static pressure source, the means for selecting one or the other source must be designed so that:

(1) When either source is selected, the other is blocked off; and

(2) Both sources cannot be blocked off simultaneously.

(d) For unpressurized aeroplanes, paragraph (c)(1) of this section does not apply if it can be demonstrated that the static pressure system calibration, when either static pressure source is selected, is not changed by the other static pressure source being open or blocked.

(e) Each static pressure system must be calibrated in flight to determine the system error. The system error, in indicated pressure altitude, at sea-level, with a standard atmosphere, excluding instrument calibration error, may not exceed ±30 feet per 100 knot speed for the appropriate configuration in the speed range between 1.3 V_{SO} with flaps extended, and 1.8 V_{S1} with flaps retracted. However, the error need not be less than 30 feet.

(f) Reserved

(g) For aeroplanes prohibited from flight in instrument meteorological or icing conditions, in accordance with 523.1559(b) of this chapter, paragraph (b)(3) of this section does not apply.

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))
(Change 523-5)

523.1326 *Pitot Heat Indication Systems*

If a flight instrument pitot heating system is installed to meet the requirements specified in 523.1323(d), an indication system must be provided to indicate to the flight crew when that pitot heating system is not operating. The indication system must comply with the following requirements:

(a) The indication provided must incorporate an amber light that is in clear view of a flight crew member.

(b) The indication provided must be designed to alert the flight crew if either of the following conditions exist:

(1) The pitot heating system is switched "off."

(2) The pitot heating system is switched "on" and any pitot tube heating element is inoperative.

(Change 523-5)

523.1327 *Magnetic Direction Indicator*

(a) Except as provided in paragraph (b) of this section:

(1) Each magnetic direction indicator must be installed so that its accuracy is not excessively affected by the aeroplane's vibration or magnetic fields; and

(2) The compensated installation may not have a deviation, in level flight, greater than ten degrees on any heading.

(b) A magnetic non-stabilised direction indicator may deviate more than ten degrees due to the operation of electrically powered systems such as electrically heated windshields if either a magnetic stabilised direction indicator, which does not have a deviation in level flight greater than ten degrees on any heading, or a gyroscopic direction indicator, is installed. Deviations of a magnetic non-stabilised direction indicator of more than 10 degrees must be placarded in accordance with 523.1547 (e).

523.1329 *Automatic Pilot System*

If an automatic pilot system is installed, it must meet the following:

(a) Each system must be designed so that the automatic pilot can:

(1) Be quickly and positively disengaged by the pilots to prevent it from interfering with their control of the aeroplane; or

(2) Be sufficiently overpowered by one pilot to let him control the aeroplane.

(b) If the provisions of paragraph (a)(1) of this section are applied, the quick release (emergency) control must be located on the control wheel (both control wheels if the aeroplane can be operated from either pilot seat) on the side opposite the throttles, or on the stick control (both stick controls, if the aeroplane can be operated from either pilot seat), such that it can be operated without moving the hand from its normal position on the control.

(c) Unless there is automatic synchronisation, each system must have a means to readily indicate to the pilot the alignment of the actuating device in relation to the control system it operates.

(d) Each manually operated control for the system operation must be readily accessible to the pilot. Each control must operate in the same plane and sense of motion as specified in 523.779 for cockpit controls. The direction of motion must be plainly indicated on or near each control.

(e) Each system must be designed and adjusted so that, within the range of adjustment available to the pilot, it cannot produce hazardous loads on the aeroplane or create hazardous deviations in the flight path, under any flight condition appropriate to its use,

either during normal operation or in the event of a malfunction, assuming that corrective action begins within a reasonable period of time.

(f) Each system must be designed so that a single malfunction will not produce a hard over signal in more than one control axis. If the automatic pilot integrates signals from auxiliary controls or furnishes signals for operation of other equipment, positive interlocks and sequencing of engagement to prevent improper operation are required.

(g) There must be protection against adverse interaction of integrated components, resulting from a malfunction.

(h) If the automatic pilot system can be coupled to airborne navigation equipment, means must be provided to indicate to the flight crew the current mode of operation. Selector switch position is not acceptable as a means of indication.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1331 *Instruments Using a Power Source*

For each instrument that uses a power source, the following apply:

(a) Each instrument must have an integral visual power annunciator or separate power indicator to indicate when power is not adequate to sustain proper instrument performance. If a separate indicator is used, it must be located so that the pilot using the instruments can monitor the indicator with minimum head and eye movement. The power must be sensed at or near the point where it enters the instrument. For electric and vacuum/pressure instruments, the power is considered to be adequate when the voltage or the vacuum/pressure, respectively, is within approved limits.

(b) The installation and power supply systems must be designed so that:

(1) The failure of one instrument will not interfere with the proper supply of energy to the remaining instrument; and

(2) The failure of the energy supply from one source will not interfere with the proper supply of energy from any other source.

(c) There must be at least two independent sources of power (not driven by the same engine on multi-engine aeroplanes), and a manual or an automatic means to select each power source.

(Change 523-4 (96-09-01))

523.1335 *Flight Director Systems*

If a flight director system is installed, means must be provided to indicate to the flight crew its current mode of operation. Selector switch position is not acceptable as a means of indication.

523.1337 *Powerplant Instruments Installation*

(a) Instruments and instrument lines.

(1) Each powerplant and auxiliary power unit instrument line must meet the requirements of 523.993.

(2) Each line carrying flammable fluids under pressure must:

(i) Have restricting orifices or other safety devices at the source of pressure to prevent the escape of excessive fluid if the line fails; and

(ii) Be installed and located so that the escape of fluids would not create a hazard.

(3) Each powerplant and auxiliary power unit instrument that utilizes flammable fluids must be installed and located so that the escape of fluid would not create a hazard.

(b) Fuel quantity indication. There must be a means to indicate to the flight crew members the quantity of usable fuel in each tank during flight. An indicator calibrated in appropriate units and clearly marked to indicate those units must be used. In addition:

(1) Each fuel quantity indicator must be calibrated to read "zero" during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply determined under 523.959(a);

(2) Each exposed sight gauge used as a fuel quantity indicator must be protected against damage;

(3) Each sight gauge that forms a trap in which water can collect and freeze must have means to allow drainage on the ground;

(4) There must be a means to indicate the amount of usable fuel in each tank when the aeroplane is on the ground (such as by a stick gauge);

(5) Tanks with interconnected outlets and airspaces may be considered as one tank and need not have separate indicators; and

(6) No fuel quantity indicator is required for an auxiliary tank that is used only to transfer fuel to other tanks if the relative size of the tank, the rate of fuel transfer, and operating instructions are adequate to:

(i) Guard against overflow; and

(ii) Give the flight crew members prompt warning if transfer is not proceeding as planned.

(c) Fuel flow meter system. If a fuel flow meter system is installed, each metering component must have a means to by-pass the fuel supply if malfunctioning of that component severely restricts fuel flow.

(d) Oil quantity indicator. There must be a means to indicate the quantity of oil in each tank:

(1) On the ground (such as by a stick gauge); and

(2) In flight, to the flight crew members, if there is an oil transfer system or a reserve oil supply system.

(Change 523-4 (96-09-01))
(Change 523-5)

Electrical Systems and Equipment

523.1351 *General*

(a) Electrical system capacity. Each electrical system must be adequate for the intended use. In addition:

(1) Electric power sources, their transmission cables, and their associated control and protective devices, must be able to furnish the required power at the proper voltage to each load circuit essential for safe operation; and

(2) Compliance with paragraph (a)(1) of this section must be shown as follows:

(i) For normal, utility, and aerobatic category aeroplanes, by an electrical load analysis or by electrical measurements that account for the electrical loads applied to the electrical system in probable combinations and for probable durations; and

(ii) For commuter category aeroplanes, by an electrical load analysis that accounts for the electrical loads applied to the electrical system in probable combinations and for probable durations.

(b) Function. For each electrical system, the following apply:

(1) Each system, when installed, must be:

(i) Free from hazards in itself, in its method of operation, and in its effects on the other parts of the aeroplane;

(ii) Protected from fuel, oil water, other detrimental substances, and mechanical damage; and

(iii) So designed that the risk of electrical shock to crew, passengers, and ground personnel is reduced to a minimum.

(2) Electric power sources must function properly when connected in combination or independently.

(3) No failure or malfunction of any electric power source may impair the ability of any remaining source to supply load circuits essential for safe operation.

(4) In addition, for commuter category aeroplanes, the following apply:

(i) Each system must be designed so that essential load circuits can be supplied in the event of reasonably probable faults or open circuit including faults in heavy current carrying cables;

(ii) A means must be accessible in flight to the flight crewmembers for the individual and collective disconnection of the electrical power sources from the system;

(iii) The system must be designed so that voltage and frequency, if applicable, at the terminals of all essential load equipment can be maintained within the limits for which the equipment is designed during any probable operating conditions;

(iv) If two independent sources of electrical power for particular equipment or systems are required, their electrical energy supply must be ensured by means such as duplicate electrical equipment, throw over switching, or multi-channel or loop circuits separately routed; and

(v) For the purpose of complying with paragraph (b)(5), the distribution system includes the distribution busses, their associated feeders, and each control and protective device.

(c) Generating system. There must be at least one generator/alternator if the electrical system supplies power to load circuits essential for safe operation. In addition:

(1) Each generator/alternator must be able to deliver its continuous rated power, or such power as is limited by its regulation system.

(2) Generator/alternator voltage control equipment must be able to dependably regulate the generator/alternator output within rated limits.

(3) Automatic means must be provided to prevent damage to any generator/alternator and adverse effects on the aeroplane electrical system due to reverse current. A means must also be provided to disconnect each generator/alternator from the battery and other generators/alternators.

(4) There must be a means to give immediate warning to the flight crew of a failure of any generator/ alternator.

(5) Each generator/alternator must have an over voltage control designed and installed to prevent damage to the electrical system, or to equipment supplied by the electrical system that could result if that generator/alternator were to develop an over voltage condition.

(d) Instruments. A means must exist to indicate to appropriate flight crewmembers the electric power system quantities essential for safe operation.

(1) For normal, utility, and aerobatic category aeroplanes with direct current systems, an ammeter that can be switched into each generator feeder may be used and, if only one generator exists, the ammeter may be in the battery feeder.

(2) For commuter category aeroplanes, the essential electric power system quantities include the voltage and current supplied by each generator.

(e) Fire resistance. Electrical equipment must be so designed and installed that in the event of a fire in the engine compartment, during which the surface of the firewall adjacent to the fire is heated to 2000°F for 5 minutes or to a lesser temperature substantiated by the applicant, the equipment essential to continued safe operation and located behind the firewall will function satisfactorily and will not create an additional fire hazard.

(f) External power. If provisions are made for connecting external power to the aeroplane, and that external power can be electrically connected to equipment other than that used for engine starting, means must be provided to ensure that no external power supply having a reverse polarity, or a reverse phase sequence, can supply power to the aeroplane's

electrical system. The external power connection must be located so that its use will not result in a hazard to the aeroplane or ground personnel.

(g) It must be shown by analysis, tests, or both, that the aeroplane can be operated safely in VFR conditions, for a period of not less than five minutes, with the normal electrical power (electrical power sources excluding the battery and any other standby electrical sources) inoperative, with critical type fuel (from the standpoint of flameout and restart capability), and with the aeroplane initially at the maximum certificated altitude. Parts of the electrical system may remain on if:

(1) A single malfunction, including a wire bundle or junction box fire, cannot result in loss of the part turned off and the part turned on; and

(2) The parts turned on are electrically and mechanically isolated from the parts turned off.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

523.1353 *Storage Battery Design and Installation*

(a) Each storage battery must be designed and installed as prescribed in this section.

(b) Safe cell temperatures and pressures must be maintained during any probable charging and discharging condition. No uncontrolled increase in cell temperature may result when the battery is recharged (after previous complete discharge):

(1) At maximum regulated voltage or power;

(2) During a flight of maximum duration; and

(3) Under the most adverse cooling condition likely to occur in service.

(c) Compliance with paragraph (b) of this section must be shown by tests unless experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures presents no problem.

(d) No explosive or toxic gases emitted by any battery in normal operation, or as the result of any probable malfunction in the charging system or battery installation, may accumulate in hazardous quantities within the aeroplane.

(e) No corrosive fluids or gases that may escape from the battery may damage surrounding structures or adjacent essential equipment.

(f) Each nickel cadmium battery installation capable of being used to start an engine or auxiliary power unit must have provisions to prevent any hazardous effect on structure or essential systems that may be caused by the maximum amount of heat the battery can generate during a short circuit of the battery or of its individual cells.

(g) Nickel cadmium battery installations capable of being used to start an engine or auxiliary power unit must have:

(1) A system to control the charging rate of the battery automatically so as to prevent battery overheating;

(2) A battery temperature sensing and over-temperature warning system with a means for disconnecting the battery from its charging source in the event of an over temperature condition; or

(3) A battery failure sensing and warning system with a means for disconnecting the battery from its charging source in the event of the battery failure.

(h) In the event of a complete loss of the primary electrical power generating system, the battery must be capable of providing at least 30 minutes of electrical power to those loads that are essential to continued safe flight and landing. The 30 minute time period includes the time needed for the pilots to recognize the loss of generated power and take appropriate load shedding action.

(Change 523-5)

523.1357 *Circuit Protective Devices*

(a) Protective devices, such as fuses or circuit breakers, must be installed in all electrical circuits other than:

(1) Main circuits of starter motors used during starting only; and

(2) Circuits in which no hazard is presented by their omission.

(b) A protective device for a circuit essential to flight safety may not be used to protect any other circuit.

(c) Each resettable circuit protective device ("trip free" device in which the tripping mechanism cannot be overridden by the operating control) must be designed so that:

(1) A manual operation is required to restore service after tripping; and

(2) If an overload or circuit fault exists, the device will open the circuit regardless of the position of the operating control.

(d) If the ability to reset a circuit breaker or replace a fuse is essential to safety in flight, that circuit breaker or fuse must be so located and identified that it can be readily reset or replaced in flight.

(e) For fuses identified as replaceable in flight:

(1) There must be one spare of each rating or 50 percent spare fuses of each rating, whichever is greater; and

(2) The spare fuse(s) must be readily accessible to any required pilot.

(Change 523-4 (96-09-01))

523.1359 *Electrical System Fire Protection*

(a) Each component of the electrical system must meet the applicable fire protection requirements of 523.863 and 523.1182.

(b) Electrical cables, terminals, and equipment in designated fire zones that are used during emergency procedures must be fire-resistant.

(c) Insulation on electrical wire and electrical cable must be self-extinguishing when tested at an angle of 60 degrees in accordance with the applicable portions of Appendix F of this Chapter, or other approved equivalent methods. The average burn length must not exceed 3 inches (76 mm) and the average flame time after removal of the flame source must not exceed 30 seconds. Drippings from the test specimen must not continue to flame for more than an average of 3 seconds after falling.

(Change 523-5)

523.1361 *Master Switch Arrangement*

(a) There must be a master switch arrangement to allow ready disconnection of each electric power source from power distribution systems, except as provided in paragraph (b) of this section. The point of disconnection must be adjacent to the sources controlled by the switch arrangement. If separate switches are incorporated into the master switch arrangement, a means must be provided for the switch arrangement to be operated by one hand with a single movement.

(b) Load circuits may be connected so that they remain energised when the master switch is open, if the circuits are isolated, or physically shielded, to prevent their igniting flammable fluids or vapours that might be liberated by the leakage or rupture of any flammable fluid system; and:

(1) The circuits are required for continued operation of the engine; or

(2) The circuits are protected by circuit protective devices with a rating of five amperes or less adjacent to the electric power source.

(3) In addition, two or more circuits installed in accordance with the requirements of paragraph (b)(2) of this section must not be used to supply a load of more than five amperes.

(c) The master switch or its controls must be so installed that the switch is easily discernible and accessible to a crew member.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1365 *Electric Cables and Equipment*

(a) Each electric connecting cable must be of adequate capacity.

(b) Any equipment that is associated with any electrical cable installation and that would overheat in the event of circuit overload or fault must be flame resistant. That equipment and the electrical cables must not emit dangerous quantities of toxic fumes.

(c) Main power cables (including generator cables) in the fuselage must be designed to allow a reasonable degree of deformation and stretching without failure and must:

(1) Be separated from flammable fluid lines; or

(2) Be shrouded by means of electrically insulated flexible conduit, or equivalent, which is in addition to the normal cable insulation.

(d) Means of identification must be provided for electrical cables, terminals, and connectors.

(e) Electrical cables must be installed such that the risk of mechanical damage and/or damage caused by fluids vapours, or sources of heat, is minimized.

(f) Where a cable cannot be protected by a circuit protection device or other overload protection, it must not cause a fire hazard under fault conditions.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1367 *Switches*

Each switch must be:

(a) Able to carry its rated current;

(b) Constructed with enough distance or insulating material between current carrying parts and the housing so that vibration in flight will not cause shorting;

(c) Accessible to appropriate flight crew members; and

(d) Labelled as to operation and the circuit controlled.

Lights

523.1381 *Instrument Lights*

The instrument lights must:

(a) Make each instrument and control easily readable and discernible;

(b) Be installed so that their direct rays, and rays reflected from the windshield or other surface, are shielded from the pilot's eyes; and

(c) Have enough distance or insulating material between current carrying parts and the housing so that vibration in flight will not cause shorting. A cabin dome light is not an instrument light.

523.1383 *Taxi and Landing Lights*

Each taxi and landing light must be designed and installed so that:

(a) No dangerous glare is visible to the pilots.

(b) The pilot is not seriously affected by halation.

(c) It provides enough light for night operations.

(d) It does not cause a fire hazard in any configuration.

(Change 523-5)

523.1385 *Position Light System Installation*

(a) General. Each part of each position light system must meet the applicable requirements of this section and each system as a whole must meet the requirements of 523.1387 through 523.1397.

(b) Left and right position lights. Left and right position lights must consist of a red and a green light spaced laterally as far apart as practicable and installed on the aeroplane such that, with the aeroplane in the normal flying position, the red light is on the left side and the green light is on the right side.

(c) Rear position light. The rear position light must be a white light mounted as far aft as practicable on the tail or on each wing tip.

(d) Light covers and colour filters. Each light cover or colour filter must be at least flame resistant and may not change colour or shape or lose any appreciable light transmission during normal use.

(Change 523-4 (96-09-01))

523.1387 *Position Light System Dihedral Angles*

(a) Except as provided in paragraph (e) of this section, each position light must, as installed, show unbroken light within the dihedral angles described in this section.

(b) Dihedral angle L (left) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the aeroplane, and the other at 110° to the left of the first, as viewed when looking forward along the longitudinal axis.

(c) Dihedral angle R (right) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the aeroplane, and the other at 110° to the right of the first, as viewed when looking forward along the longitudinal axis.

(d) Dihedral angle A (aft) is formed by two intersecting vertical planes making angles of 70° to the right and to the left, respectively, to a vertical plane passing through the longitudinal axis, as viewed when looking aft along the longitudinal axis.

(e) If the rear position light, when mounted as far aft as practicable in accordance with 523.1385 (c), cannot show unbroken light within dihedral angle A (as defined in paragraph (d) of this section), a solid angle or angles of obstructed visibility totalling not more than 0.04 steradians is allowable within that dihedral angle, if such solid angle is within a cone whose apex is at the rear position light and whose elements make an angle of 30° with a vertical line passing through the rear position light.

(Change 523-4 (96-09-01))

523.1389 *Position Light Distribution and Intensities*

(a) General. The intensities prescribed in this section must be provided by new equipment with each light cover and colour filter in place. Intensities must be determined with the light source operating at a steady value equal to the average luminous output of the source

at the normal operating voltage of the aeroplane. The light distribution and intensity of each position light must meet the requirements of paragraph (b) of this section.

(b) Position lights. The light distribution and intensities of position lights must be expressed in terms of minimum intensities in the horizontal plane, minimum intensities in any vertical plane, and maximum intensities in overlapping beams, within dihedral angles L, R, and A, and must meet the following requirements:

(1) Intensities in the horizontal plane. Each intensity in the horizontal plane (the plane containing the longitudinal axis of the aeroplane and perpendicular to the plane of symmetry of the aeroplane) must equal or exceed the values in 523.1391.

(2) Intensities in any vertical plane. Each intensity in any vertical plane (the plane perpendicular to the horizontal plane) must equal or exceed the appropriate value in 523.1393, where I is the minimum intensity prescribed in 523.1391 for the corresponding angles in the horizontal plane.

(3) Intensities in overlaps between adjacent signals. No intensity in any overlap between adjacent signals may exceed the values in 523.1395, except that higher intensities in overlaps may be used with main beam intensities substantially greater than the minima specified in 523.1391 and 523.1393, if the overlap intensities in relation to the main beam intensities do not adversely affect signal clarity. When the peak intensity of the left and right position lights is more than 100 candles, the maximum overlap intensities between them may exceed the values in 523.1395 if the overlap intensity in Area A is not more than 10 percent of peak position light intensity and the overlap intensity in Area B is not more than 2.5 percent of peak position light intensity.

(c) Rear position light installation. A single rear position light may be installed in a position displaced laterally from the plane of symmetry of an aeroplane if:

(1) The axis of the maximum cone of illumination is parallel to the flight path in level flight; and

(2) There is no obstruction aft of the light and between planes 70° to the right and left of the axis of maximum illumination.

(Change 523-4 (96-09-01))

523.1391 *Minimum Intensities in the Horizontal Plane of Position Lights*

Each position light intensity must equal or exceed the applicable values in Table below.

Dihedral Angle (Light Included)	*Angle From Right Or Left Of Longitudinal Axis, Measured From Dead Ahead*	*Intensity (Candles)*
L and R (red and green)	0° to 10°	40
	10° to 20°	30
A (rear white)	20° to 110	5
	110° to 180°	20

(Change 523-4 (96-09-01))

523.1393 *Minimum Intensities in any Vertical Plane of Position Lights*

Each position light intensity must equal or exceed the applicable values in Table below:

Angle Above Or Below The Horizontal Plane	*Intensity*
0	1.00 I
0 to 5	0.90 I
5 to 10	0.80 I
10 to 15	0.70 I
15 to 20	0.50 I
20 to 30	0.30 I
30 to 40	0.10 I
40 to 90	0.05 I

(Change 523-4 (96-09-01))

523.1395 *Maximum Intensities in Overlapping Beams of Position Lights*

No position light intensity may exceed the applicable values in Table below, except as provided in 523.1389 (b)(3):

Overlaps	*Maximum Intensity*	
	Area A (candles	Area B (candles)
Green in dihedral angle L	10	1
Red in dihedral angle R	10	1
Green in dihedral angle A	5	1
Red in dihedral angle A	5	1
Rear white in dihedral angle L	5	1
Rear white in dihedral angle R	5	1

Where:

(a) Area A includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 10° but less than 20°; and

(b) Area B includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 20°.

(Change 523-4 (96-09-01))

523.1397 *Colour Specifications*

Each position light colour must have the applicable International Commission on Illumination chromaticity co-ordinates as follows:

(a) Aviation red:

"y" is not greater than 0.335; and

"z" is not greater than 0.002.

(b) Aviation green:

"x" is not greater than 0.440-0.320 y;

"x" is not greater than y-0.170; and

"y" is not less than 0.390-0.170x.

(c) Aviation white:

"x" is not less than 0.300 and not greater than 0.540;

"y" is not less than "x-0.040" or "yo-0.010", whichever is the smaller; and

"y" is not greater than "x+0.020" nor "0.636-0.400x";

Where "yo" is the "y" co-ordinate of the Planckian radiator for the value of "x" considered.

523.1399 *Riding Light*

(a) Each riding (anchor) light required for a seaplane or amphibian, must be installed so that it can:

(1) Show a white light for at least two miles at night under clear atmospheric conditions; and

(2) Show the maximum unbroken light practicable when the aeroplane is moored or drifting on the water.

(b) Externally hung lights may be used.

523.1401 *Anti-collision Light System*

(a) General. The aeroplane must have an anti-collision light system that:

(1) Consists of one or more approved anti-collision lights located so that their light will not impair the flight crew members' vision or detract from the conspicuity of the position lights; and

(2) Meets the requirements of paragraphs (b) through (f) of this section.

(b) Field of coverage. The system must consist of enough lights to illuminate the vital areas around the aeroplane, considering the physical configuration and flight characteristics of the aeroplane. The field of coverage must extend in each direction within at least 75° above and 75° below the horizontal plane of the aeroplane, except that there may be solid angles of obstructed visibility totalling not more than 0.5 steradians.

(c) Flashing characteristics. The arrangement of the system, that is, the number of light sources, beam width, speed of rotation, and other characteristics, must give an effective flash frequency of not less than 40, nor more than 100, cycles per minute. The effective flash frequency is the frequency at which the aeroplane's complete anti-collision light system is observed from a distance, and applies to each sector of light including any overlaps that exist when the system consists of more than one light source. In overlaps, flash frequencies may exceed 100, but not 180 cycles per minute.

(d) Colour. Each anti-collision light must be either aviation red or aviation white and must meet the applicable requirements of 523.1397.

(e) Light intensity. The minimum light intensities in any vertical plane, measured with the red filter (if used) and expressed in terms of "effective" intensities, must meet the requirements of paragraph (f) of this section. The following relation must be assumed:

$$I_e = \frac{\int_{t_1}^{t_2} I(t)\,dt}{0.2 + (t_2 - t_1)}$$

where:

I_e = effective intensity (candles).

$I(t)$ = instantaneous intensity as a function of time.

$t_2 - t_1$ = flash time interval (seconds).

Normally, the maximum value of effective intensity is obtained when t_2 and t_1 are chosen so that the effective intensity is equal to the instantaneous intensity at t_2 and t_1.

(f) Minimum effective intensities for anti-collision lights. Each anti-collision light effective intensity must equal or exceed the applicable values in Table below.

Angle Above Or Below The Horizontal Plane	*Effective Intensity (Candles)*
0° to 5°	400
5° to 10°	240
10° to 20°	80
20° to 30°	40
30° to 75°	20

(Change 523-5)

Safety Equipment

523.1411 *General*

(a) Required safety equipment to be used by the flight crew in an emergency, such as automatic life raft releases, must be readily accessible.

(b) Stowage provision for required safety equipment must be furnished and must:

(1) Be arranged so that the equipment is directly accessible and its location is obvious; and

(2) Protect the safety equipment from damage caused by being subjected to the inertia loads resulting from the ultimate static load factors specified in 523.561 (b)(3) of this Chapter.

(Change 523-2 (89-01-01))

523.1413 *Safety Belts and Harnesses Removed*

(Change 523-2 (89-01-01))
(Change 523-5)

523.1415 *Ditching Equipment*

(a) Emergency flotation and signalling equipment required by any applicable operating rule must be installed so that it is readily available to the crew and passengers.

(b) Each raft and each life preserver must be approved.

(c) Each raft released automatically or by the pilot must be attached to the aeroplane by a line to keep it alongside the aeroplane. This line must be weak enough to break before submerging the empty raft to which it is attached.

(d) Each signalling device required by any applicable operating rule, must be accessible, function satisfactorily, and must be free of any hazard in its operation.

523.1416 *Pneumatic De-icer Boot System*

If certification with ice protection provisions is desired and a pneumatic de-icer boot system is installed:

(a) The system must meet the requirements specified in 523.1419;

(b) The system and its components must be designed to perform their intended function under any normal system operation temperature or pressure; and

(c) Means to indicate to the flight crew that the pneumatic de-icer boot system is receiving adequate pressure and is functioning normally must be provided.

523.1419 *Ice Protection*

If certification with ice protection provisions is desired, compliance with the requirements of this section and other applicable sections of this chapter must be shown:

(a) An analysis must be performed to establish, on the basis of the aeroplane's operational needs, the adequacy of the ice protection system for the various components of the aeroplane. In addition, tests of the ice protection system must be conducted to demonstrate that the aeroplane is capable of operating safely in continuous maximum and intermittent maximum icing conditions, as described in Appendix C of Chapter 525 of this manual. As used in this section, "Capable of operating safely," means that aeroplane performance, controllability, manoeuvrability, and stability must not be less than that required in Chapter 523, subchapter B.

(b) Except as provided by paragraph (c) of this section, in addition to the analysis and physical evaluation prescribed in paragraph (a) of this section, the effectiveness of the ice protection system and its components must be shown by flight tests of the aeroplane or its components in measured natural atmospheric icing conditions and by one or more of the following tests, as found necessary to determine the adequacy of the ice protection system:

(1) Laboratory dry air or simulated icing tests, or a combination of both, of the components or models of the components.

(2) Flight dry air tests of the ice protection system as a whole, or its individual components.

(3) Flight test of the aeroplane or its components in measured simulated icing conditions.

(c) If certification with ice protection has been accomplished on prior type certificated aeroplanes whose designs include components that are thermodynamically and aerodynamically equivalent to those used on a new aeroplane design, certification of these equivalent components may be accomplished by reference to previously accomplished tests, required in 523.1419(a) and (b), provided that the applicant accounts for any differences in installation of these components.

(d) A means must be identified or provided for determining the formation of ice on the critical parts of the aeroplane. Adequate lighting must be provided for the use of this means during night operation. Also, when monitoring of the external surfaces of the aeroplane by the flight crew is required for operation of the ice protection equipment, external lighting must be provided that is adequate to enable the monitoring to be done at night. Any illumination that is used must be of a type that will not cause glare or reflection that would handicap crewmembers in the performance of their duties. The Aeroplane Flight Manual or other approved manual material must describe the means of determining ice formation and must contain information for the safe operation of the aeroplane in icing conditions.

(Change 523-4 (96-09-01))

Miscellaneous Equipment

523.1431 *Electronic Equipment*

(a) In showing compliance with 523.1309(b)(1) and (2) with respect to radio and electronic equipment and their installations, critical environmental conditions must be considered.

(b) Radio and electronic equipment, controls, and wiring must be installed so that operation of any unit or system of units will not adversely affect the simultaneous operation of any other radio or electronic unit, or system of units, required by this manual.

(c) For those aeroplanes required to have more than one flight crew member, or whose operation will require more than one flight crew member, the cockpit must be evaluated to determine if the flight crew members, when seated at their duty station, can converse without difficulty under the actual cockpit noise conditions when the aeroplane is being operated. If the aeroplane design includes provision for the use of communication headsets, the evaluation must also consider conditions where headsets are being used. If the evaluation shows conditions under which it will be difficult to converse, an inter-communication system must be provided.

(d) If installed communication equipment includes transmitter "off-on" switching, that switching means must be designed to return from the "transmit" to the "off" position when it is released and ensure that the transmitter will return to the off (non transmitting) state.

(e) If provisions for the use of communication headsets are provided, it must be demonstrated that the flight crew members will receive all aural warnings under the actual cockpit noise conditions when the aeroplane is being operated when any headset is being used.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1435 *Hydraulic Systems*

(a) *Design*. Each hydraulic system must be designed as follows:

(1) Each hydraulic system and its elements must withstand, without yielding, the structural loads expected in addition to hydraulic loads.

(2) A means to indicate the pressure in each hydraulic system, which supplies two or more primary functions, must be provided to the flight crew.

(3) There must be means to ensure that the pressure, including transient (surge) pressure, in any part of the system will not exceed the safe limit above design operating pressure and to prevent excessive pressure resulting from fluid volumetric changes in all lines which are likely to remain closed long enough for such changes to occur.

(4) The minimum design burst pressure must be 2.5 times the operating pressure.

(b) *Tests*. Each system must be substantiated by proof pressure tests. When proof tested, no part of any system may fail, malfunction, or experience a permanent set. The proof load of each system must be at least 1.5 times the maximum operating pressure of that system.

(c) *Accumulators*. A hydraulic accumulator or reservoir may be installed on the engine side of any firewall if:

(1) It is an integral part of an engine or propeller system, or

(2) The reservoir is non-pressurized and the total capacity of all such non-pressurized reservoirs is one quart or less.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1437 *Accessories for Multi-engine Aeroplanes*

For multi-engine aeroplanes, engine driven accessories essential to safe operation must be distributed among two or more engines so that the failure of any one engine will not impair safe operation through the malfunctioning of these accessories.

523.1438 *Pressurisation and Pneumatic Systems*

(a) Pressurization system elements must be burst pressure tested to 2.0 times, and proof pressure tested to 1.5 times, the maximum normal operating pressure.

(b) Pneumatic system elements must be burst pressure tested to 3.0 times, and proof pressure tested to 1.5 times, the maximum normal operating pressure.

(c) An analysis, or a combination of analysis and test, may be substituted for any test required by paragraph (a) or (b) of this section if the Minister finds it equivalent to the required test.

523.1441 *Oxygen Equipment and Supply*

(a) If certification with supplemental oxygen equipment is requested, or the aeroplane is approved for operations at or above altitudes where oxygen is required to be used by the operating rules, oxygen equipment must be provided that meets the requirements of this section and 523.1443 through 523.1449. Portable oxygen equipment may be used to meet the requirements of this part if the portable equipment is shown to comply with the applicable requirements, is identified in the aeroplane type design, and its stowage provisions are found to be in compliance with the requirements of 523.561.

(b) The oxygen system must be free from hazards in itself, in its method of operation, and its effect upon other components.

(c) There must be a means to allow the crew to readily determine, during the flight, the quantity of oxygen available in each source of supply.

(d) Each required flight crewmember must be provided with:

(1) Demand oxygen equipment if the aeroplane is to be certificated for operation above 25,000 feet.

(2) Pressure demand oxygen equipment if the aeroplane is to be certificated for operation above 40,000 feet.

(e) There must be a means, readily available to the crew in flight, to turn on and to shut off the oxygen supply at the high pressure source. This shut-off requirement does not apply to chemical oxygen generators.

(Change 523-4 (96-09-01))

523.1443 *Minimum Mass Flow of Supplemental Oxygen*

(a) If continuous flow oxygen equipment is installed, an applicant must show compliance with the requirements of either paragraphs (a)(1) and (a)(2) or paragraph (a)(3) of this section:

(1) For each passenger, the minimum mass flow of supplemental oxygen required at various cabin pressure altitudes may not be less than the flow required to maintain, during inspiration and while using the oxygen equipment (including masks) provided, the following mean tracheal oxygen partial pressures;

(i) At cabin pressure altitudes above 10,000 feet up to and including 18,500 feet, a mean tracheal oxygen partial pressure of 100 mm. Hg when breathing 15 litres per minute, Body Temperature, Pressure, Saturated (BTPS) and with a tidal volume of 700 cc. with a constant time interval between respirations.

(ii) At cabin pressure altitudes above 18,500 feet up to and including 40,000 feet, a mean tracheal oxygen partial pressure of 83.8 mm. Hg when breathing 30 litres per minute, BTPS, and with a tidal volume of 1,100 cc. with a constant time interval between respirations.

(2) For each flight crewmember, the minimum mass flow may not be less than the flow required to maintain, during inspiration, a mean tracheal oxygen partial pressure of 149 mm. Hg when breathing 15 litres per minute, BTPS, and with a maximum tidal volume of 700 cc. with a constant time interval between respirations.

(3) The minimum mass flow of supplemental oxygen supplied for each user must be at a rate not less than that shown in Figure F1 for each altitude up to and including the maximum operating altitude of the aeroplane.

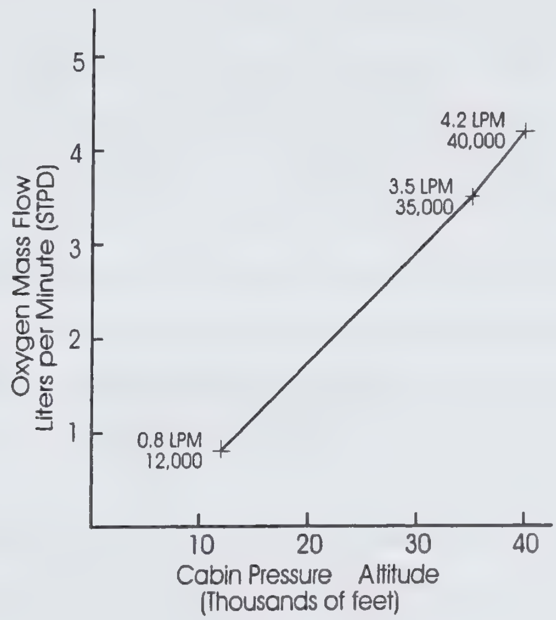


Figure F1

(b) If demand equipment is installed for use by flight crewmembers, the minimum mass flow of supplemental oxygen required for each flight crewmember may not be less than the flow required to maintain, during inspiration, a mean tracheal oxygen partial pressure of 122 mm. Hg up to and including a cabin pressure altitude of 35,000 feet, and 95 percent oxygen between cabin pressure altitudes of 35,000 and 40,000 feet, when breathing 20 litres per minute BTPS. In addition, there must be means to allow the crew to use undiluted oxygen at their discretion.

(c) If first-aid oxygen equipment is installed, the minimum mass flow of oxygen to each user may not be less than 4 litres per minute, STPD. However, there may be a means to decrease this flow to not less than 2 litres per minute, STPD, at any cabin altitude. The quantity of oxygen required is based upon an average flow rate of 3 litres per minute per person for whom first-aid oxygen is required.

(d) As used in this section:

(1) BTPS means Body Temperature, and Pressure, Saturated (which is, 37°C, and the ambient pressure to which the body is exposed, minus 47 mm. Hg, which is the tracheal pressure displaced by water vapour pressure when the breathed air becomes saturated with water vapour at 37°C).

(2) STPD means Standard, Temperature, and Pressure, Dry (which is, 0°C at 760 mm. Hg with no water vapour).

(Change 523-4 (96-09-01))

523.1445 *Oxygen Distribution System*

(a) Except for flexible lines from oxygen outlets to the dispensing units, or where shown to be otherwise suitable to the installation, non-metallic tubing must not be used for any oxygen line that is normally pressurised during flight.

(b) Non-metallic oxygen distribution lines must not be routed where they may be subjected to elevated temperatures, electrical arcing, and released flammable fluids that might result from any probable failure.

(Change 523-4 (96-09-01))

523.1447 *Equipment Standards for Oxygen Dispensing Units*

If oxygen dispensing units are installed, the following apply:

(a) There must be an individual dispensing unit for each occupant for whom supplemental oxygen is to be supplied. Each dispensing unit must:

(1) Provide for effective utilisation of the oxygen being delivered to the unit.

(2) Be capable of being readily placed into position on the face of the user.

(3) Be equipped with a suitable means to retain the unit in position on the face.

(4) If radio equipment is installed, the flight crew oxygen dispensing units must be designed to allow the use of that equipment and to allow communication with any other required crew member while at their assigned duty station.

(b) If certification for operation up to and including 18,000 feet (MSL) is requested, each oxygen dispensing unit must:

(1) Cover the nose and mouth of the user; or

(2) Be a nasal cannula, in which case one oxygen dispensing unit covering both the nose and mouth of the user must be available. In addition, each nasal cannula or its connecting tubing must have permanently affixed:

(i) A visible warning against smoking while in use;

(ii) An illustration of the correct method of donning; and

(iii) A visible warning against use with nasal obstructions or head colds with resultant nasal congestion.

(c) If certification for operation above 18,000 feet (MSL) is requested, each oxygen dispensing unit must cover the nose and mouth of the user.

(d) For a pressurized aeroplane designed to operate at flight altitudes above 25,000 feet (MSL), the dispensing units must meet the following:

(1) The dispensing units for passengers must be connected to an oxygen supply terminal and be immediately available to each occupant wherever seated.

(2) The dispensing units for crew members must be automatically presented to each crew member before the cabin pressure altitude exceeds 15,000 feet, or the units must be of the quick-donning type, connected to an oxygen supply terminal that is immediately available to crew members at their station.

(e) If certification for operation above 30,000 feet is requested, the dispensing units for passengers must be automatically presented to each occupant before the cabin pressure altitude exceeds 15,000 feet.

(f) If an automatic dispensing unit (hose and masks, or other unit) system is installed, the crew must be provided with a manual means to make the dispensing units immediately available in the event of failure of the automatic system.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1449 *Means for Determining Use of Oxygen*

There must be a means to allow the crew to determine whether oxygen is being delivered to the dispensing equipment.

523.1450 Chemical Oxygen Generators

(a) For the purpose of this section, a chemical oxygen generator is defined as a device which produces oxygen by chemical reaction.

(b) Each chemical oxygen generator must be designed and installed in accordance with the following requirements:

(1) Surface temperature developed by the generator during operation may not create a hazard to the aeroplane or to its occupants.

(2) Means must be provided to relieve any internal pressure that may be hazardous.

(c) In addition to meeting the requirements in paragraph (b) of this section, each portable chemical oxygen generator that is capable of sustained operation by successive replacement of a generator element must be placarded to show:

(1) The rate of oxygen flow, in litres per minute;

(2) The duration of oxygen flow in minutes, for the replaceable generator element; and

(3) A warning that the replaceable generator element may be hot, unless the element construction is such that the surface temperature cannot exceed 100 degrees F.

523.1451 *Fire Protection For Oxygen Equipment*

Oxygen equipment and lines must:

(a) Not be installed in any designated fire zones.

(b) Be protected from heat that may be generated in, or escape from, any designated fire zone.

(c) Be installed so that escaping oxygen cannot come in contact with and cause ignition of grease, fluid, or vapour accumulations that are present in normal operation or that may result from the failure or malfunction of any other system.

(Change 523-5)

523.1453 *Protection Of Oxygen Equipment From Rupture*

(a) Each element of the oxygen system must have sufficient strength to withstand the maximum pressure and temperature, in combination with any externally applied loads arising from consideration of limit structural loads, that may be acting on that part of the system.

(b) Oxygen pressure sources and the lines between the source and the shut-off means must be:

(1) Protected from unsafe temperatures; and

(2) Located where the probability and hazard of rupture in a crash landing are minimized.

(Change 523-5)

523.1457 *Cockpit Voice Recorders*

(a) Each cockpit voice recorder required by the applicable operating rules must be approved and must be installed so that it will record the following:

(1) Voice communications transmitted from or received in the aeroplane by radio.

(2) Voice communications of flight crewmembers on the flight deck.

(3) Voice communications of flight crewmembers on the flight deck, using the aeroplane's interphone system.

(4) Voice or audio signals identifying navigation or approach aids introduced into a headset or speaker.

(5) Voice communications of flight crewmembers using the passenger loudspeaker system, if there is such a system and if the fourth channel is available in accordance with the requirements of paragraph (c)(4)(ii) of this section.

(6) If datalink communication equipment is installed, all datalink communications, using an approved data message set. Datalink messages must be recorded as the output signal from the communications unit that translates the signal into usable data. (amended 2009/05/11)

(b) The recording requirements of paragraph (a)(2) of this section must be met by installing a cockpit-mounted area microphone, located in the best position for recording voice communications originating at the first and second pilot stations and voice communications of other crewmembers on the flight deck when directed to those stations. The microphone must be so located and, if necessary, the preamplifiers and filters of the recorder must be so adjusted or supplemented, so that the intelligibility of the recorded communications is as high as practicable when recorded under flight cockpit noise conditions and played back. Repeated aural or visual playback of the record may be used in evaluating intelligibility.

(c) Each cockpit voice recorder must be installed so that the part of the communication or audio signals specified in paragraph (a) of this section obtained from each of the following sources is recorded on a separate channel:

(1) For the first channel, from each boom, mask, or handheld microphone, headset, or speaker used at the first pilot station.

(2) For the second channel from each boom, mask, or handheld microphone, headset, or speaker used at the second pilot station.

(3) For the third channel from the cockpit-mounted area microphone.

(4) For the fourth channel from:

(i) Each boom, mask, or handheld microphone, headset, or speaker used at the station for the third and fourth crewmembers.

(ii) If the stations specified in paragraph (c)(4)(i) of this section are not required or if the signal at such a station is picked up by another channel, each microphone on the flight deck that is used with the passenger loudspeaker system, if its signals are not picked up by another channel.

(5) And that as far as is practicable all sounds received by the microphone listed in paragraphs (c)(1),(2), and (4) of this section must be recorded without interruption irrespective of the position of the interphone-transmitter key switch. The design shall ensure that side tone for the flight crew is produced only when the interphone, public address system, or radio transmitters are in use.

(d) Each cockpit voice recorder must be installed so that:

(1) It receives its electrical power from the bus that provides the maximum reliability for operation of the cockpit voice recorder without jeopardizing service to essential or emergency loads. The cockpit voice recorder must remain powered for as long as possible without jeopardizing emergency operation of the aeroplane;
(amended 2009/05/11)

(2) There is an automatic means to simultaneously stop the recorder and prevent each erasure feature from functioning, within 10 minutes after crash impact;

(3) There is an aural or visual means for pre-flight checking of the recorder for proper operation;

(4) Any single electrical failure external to the recorder does not disable both the cockpit voice recorder and the flight data recorder;
(amended 2009/05/11)

(5) It has an independent power source:
(amended 2009/05/11)

(i) That provides 10 ± 1 minutes of electrical power to operate both the cockpit voice recorder and cockpit-mounted area microphone;
(amended 2009/05/11)

(ii) That is located as close as practicable to the cockpit voice recorder; and
(amended 2009/05/11)

(iii) To which the cockpit voice recorder and cockpit-mounted area microphone are switched automatically in the event that all other power to the cockpit voice recorder is interrupted either by normal shutdown or by any other loss of power to the electrical power bus; and
(amended 2009/05/11)

(6) It is in a separate container from the flight data recorder when both are required. If used to comply with only the cockpit voice recorder requirements, a combination unit may be installed.
(amended 2009/05/11)

(e) The recorder container must be located and mounted to minimize the probability of rupture of the container as a result of crash impact and consequent heat damage to the recorder from fire.
(amended 2009/05/11)

(1) Except as provided in paragraph (e)(2) of this section, the recorder container must be located as far aft as practicable, but need not be outside of the pressurised compartment, and may not be located where aft-mounted engines may crush the container during impact;
(amended 2009/05/11)

(2) If two separate combination digital flight data recorder and cockpit voice recorder units are installed instead of one cockpit voice recorder and one digital flight data recorder, the combination unit that is installed to comply with the cockpit voice recorder requirements may be located near the cockpit.
(amended 2009/05/11)

(f) If the cockpit voice recorder has a bulk erasure device, the installation must be designed to minimize the probability of inadvertent operation and actuation of the device during crash impact.

(g) Each recorder container must:

(1) Be either bright orange or bright yellow;

(2) Have reflective tape affixed to its external surface to facilitate its location under water; and

(3) Have an underwater locating device, when required by the applicable operating rules, on or adjacent to the container which is secured in such a manner that they are not likely to be separated during crash impact.

(Change 523-2 (89-01-01))

523.1459 *Flight Data Recorders*
(amended 2009/05/11)

(a) Each flight recorder required by the applicable operating rules must be installed so that:

(1) It is supplied with airspeed, altitude, and directional data obtained from sources that meet the accuracy requirements of 523.1323, 523.1325, and 523.1327, as appropriate;

(2) The vertical acceleration sensor is rigidly attached, and located longitudinally either within the approved centre of gravity limits of the aeroplane, or at a distance forward or aft of these limits that does not exceed 25 percent of the aeroplane's mean aerodynamic chord;

(3) It receives its electrical power from the bus that provides the maximum reliability for operation of the flight data recorder without jeopardising service to essential or emergency loads. The flight data recorder must remain powered for as long as possible without jeopardizing emergency operation of the aeroplane;
(amended 2009/05/11)

(4) There is an aural or visual means for pre-flight checking of the recorder for proper recording of data in the storage medium;

(5) Except for recorders powered solely by the engine-driven electrical generator system, there is an automatic means to simultaneously stop a recorder that has a data erasure feature and prevent each erasure feature from functioning, within 10 minutes after crash impact;

(6) Any single electrical failure external to the recorder does not disable both the cockpit voice recorder and the flight data recorder; and
(amended 2009/05/11)

(7) It is in a separate container from the cockpit voice recorder when both are required. If used to comply with only the flight data recorder requirements, a combination unit may be installed. If a combination unit is installed as a cockpit voice recorder to comply with 523.1457(e)(2), a combination unit must be used to comply with this flight data recorder requirement.
(amended 2009/05/11)

(b) Each non-ejectable record container must be located and mounted so as to minimize the probability of container rupture resulting from crash impact and subsequent damage to the record from fire. In meeting this requirement the record container must be located as far aft as practicable, but need not be aft of the pressurised compartment, and may not be where aft-mounted engines may crush the container upon impact.

(c) A correlation must be established between the flight recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments. The correlation must cover the airspeed range over which the aeroplane is to be operated, the range of altitude to which the aeroplane is limited, and 360 degrees of heading. Correlation may be established on the ground as appropriate.

(d) Each recorder container must:

(1) Be either bright orange or bright yellow;

(2) Have reflective tape affixed to its external surface to facilitate its location under water; and

(3) Have an underwater locating device, when required by any applicable operating rules, on or adjacent to the container which is secured in such a manner that they are not likely to be separated during crash impact.

(e) Any novel or unique design or operational characteristics of the aircraft shall be evaluated to determine if any dedicated parameters must be recorded on flight records in addition to or in place of existing requirements.

(Change 523-2 (89-01-01))
(Change 523-3 (92-01-02))

523.1461 *Equipment Containing High Energy Rotors.*

(a) Equipment, such as Auxiliary Power Units (APU) and constant speed drive units, containing high energy rotors must meet paragraphs (b), (c), or (d) of this section.

(b) High energy rotors contained in equipment must be able to withstand damage caused by malfunctions, vibration, abnormal speeds, and abnormal temperatures. In addition:

(1) Auxiliary rotor cases must be able to contain damage caused by the failure of high energy rotor blades; and

(2) Equipment control devices, systems, and instrumentation must reasonably ensure that no operating limitations affecting the integrity of high energy rotors will be exceeded in service.

(c) It must be shown by test that equipment containing high energy rotors can contain any failure of a high energy rotor that occurs at the highest speed obtainable with the normal speed control devices inoperative.

(d) Equipment containing high energy rotors must be located where rotor failure will neither endanger the occupants nor adversely affect continued safe flight.

(Change 523-5)

SUBCHAPTER G

Operating Limitations and Information

523.1501 *General*

(a) Each operating limitation specified in 523.1505 through 523.1527 and other limitations and information necessary for safe operation must be established.

(b) The operating limitations and other information necessary for safe operation must be made available to the crew members as prescribed in 523.1541 through 523.1589.

523.1505 *Airspeed Limitations*

(a) The never-exceed speed V_{NE} must be established so that it is:

(1) Not less than 0.9 times the minimum value of V_D allowed under 523.335; and

(2) Not more than the lesser of:

(i) 0.9 V_D established under 523.335; or

(ii) 0.9 times the maximum speed shown under 523.251.

(b) The maximum structural cruising speed V_{NO} must be established so that it is:

(1) Not less than the minimum value of V_C allowed under 523.335; and

(2) Not more than the lesser of:

(i) V_C established under 523.335; or

(ii) 0.89 V_{NE} established under paragraph (a) of this section.

(c) Paragraphs (a) and (b) of this section do not apply to turbine aeroplanes or to aeroplanes for which a design diving speed V_D/M_D is established under 523.335 (b)(4). For those aeroplanes, a maximum operating limit speed (V_{MO}/ M_{MO} airspeed or Mach number, whichever is critical at a particular altitude) must be established as a speed that may not be deliberately exceeded in any regime of flight (climb, cruise, or descent) unless a higher speed is authorised for flight test or pilot training operations. V_{MO}/M_{MO} must be established so that it is not greater than the design cruising speed V_C/M_C and so that it is sufficiently below V_D/M_D and the maximum speed shown under 523.251 to make it highly improbable that the latter speeds will be inadvertently exceeded in operations. The speed margin between V_{MO}/M_{MO} and V_D/M_D or the maximum speed shown under 523.251 may not be less than the speed margin established between V_C/M_C and V_D/M_D under 523.335 (b), or the speed margin found necessary in the flight test conducted under 523.253.

523.1507 *Operating Manoeuvring Speed*

The maximum operating manoeuvring speed, V_O, must be established as an operating limitation. V_O is a selected speed that is not greater than $V_S\sqrt{n}$ established in 523.335(c).

(Change 523-4 (96-09-01))

523.1511 *Flap Extended Speed*

(a) The flap extended speed V_{FE} must be established so that it is:

(1) Not less than the minimum value of V_F allowed in 523.345(b); and

(2) Not more than V_F established under 523.345(a), (c), and (d).

(b) Additional combinations of flap setting, airspeed, and engine power may be established if the structure has been proven for the corresponding design conditions.

(Change 523-5)

523.1513 *Minimum Control Speed*

The minimum control speed V_{MC}, determined under 523.149, must be established as an operating limitation.

523.1519 *Weight and Centre of Gravity*

The weight and centre of gravity limitations determined under 523.23 must be established as operating limitations.

523.1521 *Powerplant Limitations*

(a) *General.* The powerplant limitations prescribed in this section must be established so that they do not exceed the corresponding limits for which the engines or propellers are type approved. In addition, other powerplant limitations used in determining compliance with this chapter must be established.

(b) *Takeoff operation.* The powerplant takeoff operation must be limited by:

(1) The maximum rotational speed (rpm);

(2) The maximum allowable manifold pressure (for reciprocating engines);

(3) The maximum allowable gas temperature (for turbine engines);

(4) The time limit for the use of the power or thrust corresponding to the limitations established in subparagraphs (1) through (3) of this paragraph; and

(5) The maximum allowable cylinder head (as applicable), liquid coolant and oil temperatures.

(c) *Continuous operation.* The continuous operation must be limited by:

(1) The maximum rotational speed;

(2) The maximum allowable manifold pressure (for reciprocating engines);

(3) The maximum allowable gas temperature (for turbine engines); and

(4) The maximum allowable cylinder head, oil, and liquid coolant temperatures.

(d) *Fuel grade or designation.* The minimum fuel grade (for reciprocating engines), or fuel designation (for turbine engines), must be established so that it is not less than that

required for the operation of the engines within the limitations in paragraphs (b) and (c) of this section.

(e) *Ambient temperature.* For all aeroplanes except reciprocating engine-powered aeroplanes of 6,000 pounds or less maximum weight, ambient temperature limitations (including limitations for winterization installations if applicable) must be established as the maximum ambient atmospheric temperature at which compliance with the cooling provisions of 523.1041 through 523.1047 is shown.

(Change 523-4 (96-09-01))
(Change 523-5)

523.1522 *Auxiliary Power Unit Limitations*

If an auxiliary power unit is installed, the limitations established for the auxiliary power unit must be specified in the operating limitations for the aeroplane.

(Change 523-4 (96-09-01))

523.1523 *Minimum Flight Crew*

The minimum flight crew must be established so that it is sufficient for safe operation considering:

(a) The workload on individual crew members and, in addition for commuter category aeroplanes, each crew member workload determination must consider the following:

(1) Flight path control,

(2) Collision avoidance,

(3) Navigation,

(4) Communications,

(5) Operation and monitoring of all essential aeroplane systems,

(6) Command decisions, and

(7) The accessibility and ease of operation of necessary controls by the appropriate crew member during all normal and emergency operations when at the crew member flight station.

(b) The accessibility and ease of operation of necessary controls by the appropriate crew member; and

(c) The kinds of operation authorized under 523.1525.

(Change 523-1 (88-01-01))

523.1524 *Maximum Passenger Seating Configuration*

The maximum passenger seating configuration must be established.

523.1525 *Kinds of Operation*

The kinds of operation authorised (e.g. VFR, IFR, day or night) and the meteorological conditions (e.g. icing) to which the operation of the aeroplane is limited or from which it is prohibited, must be established appropriate to the installed equipment.

(Change 523-4 (96-09-01))

523.1527 *Maximum Operating Altitude*

(a) The maximum altitude up to which operation is allowed, as limited by flight, structural, powerplant, functional or equipment characteristics, must be established.

(b) A maximum operating altitude limitation of not more than 25,000 feet must be established for pressurized aeroplanes unless compliance with 523.775(e) is shown.

(Change 523-4 (96-09-01))

523.1529 *Instructions for Continued Airworthiness*

The applicant must prepare Instructions for Continued Airworthiness in accordance with Appendix G to this Chapter that are acceptable to the Minister. The instructions may be incomplete at type certificate if a program exists to ensure their completion prior to delivery of the first aeroplane or issuance of a standard certificate of airworthiness, whichever occurs later.

Markings and Placards

523.1541 *General*

(a) The aeroplane must contain:

(1) The markings and placards specified in 523.1545 through 523.1567; and

(2) Any additional information, instrument markings, and placards required for the safe operation if it has unusual design, operating, or handling characteristics.

(b) Each marking and placard prescribed in paragraph (a) of this section:

(1) Must be displayed in a conspicuous place; and

(2) May not be easily erased, disfigured, or obscured.

(c) For aeroplanes which are to be certificated in more than one category:

(1) The applicant must select one category upon which the placards and markings are to be based; and

(2) The placards and markings information for all categories in which the aeroplane is to be certificated must be furnished in the Aeroplane Flight Manual.

523.1543 *Instrument Markings: General*

For each instrument:

(a) When markings are on the cover glass of the instrument, there must be means to maintain the correct alignment of the glass cover with the face of the dial; and

(b) Each arc and line must be wide enough and located to be clearly visible to the pilot.

(c) All related instruments must be calibrated in compatible units.

(Change 523-5)

523.1545 *Airspeed Indicator*

(a) Each airspeed indicator must be marked as specified in paragraph (b) of this section, with the marks located at the corresponding indicated airspeeds.

(b) The following markings must be made:

(1) For the never-exceed speed V_{NE}, a radial red line.

(2) For the caution range, a yellow arc extending from the red line specified in subparagraph (1) of this paragraph to the upper limit of the green arc specified in subparagraph (3) of this paragraph.

(3) For the normal operating range, a green arc with the lower limit at V_{S1} with maximum weight and with landing gear and wing flaps retracted, and the upper limit at the maximum structural cruising speed V_{NO} established under 523.1505(b).

(4) For the flap operating range, a white arc with the lower limit at V_{SO} at the maximum weight and the upper limit at the flaps extended speed V_{FE} established under 523.1511.

(5) For reciprocating multi-engine-powered aeroplanes of 6,000 pounds or less maximum weight, for the speed at which compliance has been shown with 523.69(b) relating to rate of climb at maximum weight and at sea level, a blue radial line.

(6) For reciprocating multi-engine-powered aeroplanes of 6,000 pounds or less maximum weight, for the maximum value of minimum control speed, V_{MC}, (one-engine-inoperative) determined under 523.149(b), a red radial line.

(c) If V_{NE} or V_{NO} vary with altitude, there must be means to indicate to the pilot the appropriate limitations throughout the operating altitude range.

(d) Subparagraphs (1) through (3) of paragraph (b) and paragraph (c) of this section do not apply to aircraft for which a maximum operating speed V_{MO}/M_{MO} is established under 523.1505(c). For those aircraft there must either be a maximum allowable airspeed indication showing the variation of V_{MO}/M_{MO} with altitude or compressibility limitations (as appropriate), or a radial red line marking for V_{MO}/M_{MO} established for any altitude up to the maximum operating altitude for the aeroplane.

(Change 523-5)

523.1547 *Magnetic Direction Indicator*

(a) A placard meeting the requirements of this section must be installed on or near the magnetic direction indicator.

(b) The placard must show the calibration of the instrument in level flight with the engines operating.

(c) The placard must state whether the calibration was made with radio receivers on or off.

(d) Each calibration reading must be in terms of magnetic headings in not more than 30° increments.

(e) If a magnetic non-stabilised direction indicator can have a deviation of more than 10 degrees caused by the operation of electrical equipment, the placard must state which electrical loads, or combination of loads, would cause a deviation of more than 10 degrees when turned on.

523.1549 *Powerplant and Auxiliary Power Unit Instruments*

For each required powerplant and auxiliary power unit instrument, as appropriate to the type of instruments:

(a) Each maximum and if applicable, minimum safe operating limit must be marked with a red radial or a red line;

(b) Each normal operating range must be marked with a green arc or green line not extending beyond the maximum and minimum safe limits;

(c) Each takeoff and precautionary range must be marked with a yellow arc or a yellow line; and

(d) Each engine, auxiliary power unit, or propeller range that is restricted because of excessive vibration stresses must be marked with red arcs or red lines.

(Change 523-4 (96-09-01))

523.1551 *Oil Quantity Indicator*

Each oil quantity indicator must be marked in sufficient increments to indicate readily and accurately the quantity of oil.

523.1553 *Fuel Quantity Indicator*

A red radial line must be marked on each indicator at the calibrated zero reading, as specified in 523.1337(b)(1).
(Change 523-5)

523.1555 *Control Markings*

(a) Each cockpit control, other than primary flight controls and simple push button type starter switches, must be plainly marked as to its function and method of operation.

(b) Each secondary control must be suitably marked.

(c) For powerplant fuel controls:

(1) Each fuel tank selector control must be marked to indicate the position corresponding to each tank and to each existing cross feed position;

(2) If safe operation requires the use of any tanks in a specific sequence, that sequence must be marked on or near the selector for those tanks;

(3) The conditions under which the full amount of usable fuel in any restricted usage fuel tank can safely be used must be stated on a placard adjacent to the selector valve for that tank; and

(4) Each valve control for any engine of a multi-engine aeroplane must be marked to indicate the position corresponding to each engine controlled.

(d) Usable fuel capacity must be marked as follows:

(1) For fuel systems having no selector controls, the usable fuel capacity of the system must be indicated at the fuel quantity indicator.

(2) For fuel systems having selector controls, the usable fuel capacity available at each selector control position must be indicated near the selector control.

(e) For accessory, auxiliary, and emergency controls:

(1) If retractable landing gear is used, the indicator required by 523.729 must be marked so that the pilot can, at any time, ascertain that the wheels are secured in the extreme positions; and

(2) Each emergency control must be red and must be marked as to method of operation. No control other than an emergency control, or a control that serves an emergency function in addition to its other functions, shall be this colour.

(Change 523-5)

523.1557 *Miscellaneous Markings and Placards*

(a) *Baggage and cargo compartments, and ballast location.* Each baggage and cargo compartment, and each ballast location, must have a placard stating any limitations on contents, including weight, that are necessary under the loading requirements.

(b) *Seats.* If the maximum allowable weight to be carried in a seat is less than 170 pounds, a placard stating the lesser weight must be permanently attached to the seat structure.

(c) *Fuel, oil, and coolant filler openings.* The following apply:

(1) Fuel filler openings must be marked at or near the filler cover with:

(i) For reciprocating engine powered aeroplanes:

(A) The word "Avgas"; and

(B) The minimum fuel grade.

(ii) For turbine engine-powered aeroplanes:

(A) The words "Jet Fuel"; and

(B) The permissible fuel designations, or references to the Aeroplane Flight Manual (AFM) for permissible fuel designations.

(iii) For pressure fuelling systems, the maximum permissible fuelling supply pressure and the maximum permissible defuelling pressure.

(2) Oil filler openings must be marked at or near the filler cover with the word "Oil" and the permissible oil designations, or references to the Aeroplane Flight Manual (AFM) for permissible oil designations.

(3) Coolant filler openings must be marked at or near the filler cover with the word "Coolant".

<u>(4) If placards and markings at the fuel or oil opening include tank capacity, the capacity must be specified in litres. Imperial or U.S. gallons may also be included.</u>

FAR - No corresponding text.

(d) *Emergency exit placards*. Each placard and operating control for each emergency exit must be red. A placard must be near each emergency exit control and must clearly indicate the location of that exit and its method of operation.

(e) The system voltage of each direct current installation must be clearly marked adjacent to its external power connection.

(f) (Removed)

(Change 523-4 (96-09-01))

523.1559 *Operating Limitations Placard*

(a) There must be a placard in clear view of the pilot stating:

(1) That the aeroplane must be operated in accordance with the Aeroplane Flight Manual; and

(2) The certification category of the aeroplane to which the placards apply.

(b) For aeroplanes certificated in more than one category, there must be a placard in clear view of the pilot stating that other limitations are contained in the Aeroplane Flight Manual.

(c) There must be a placard in clear view of the pilot that specifies the kind of operations to which the operation of the aeroplane is limited or from which it is prohibited under 523.1525.

(Change 523-5)

523.1561 *Safety Equipment*

(a) Safety equipment must be plainly marked as to method of operation.

(b) Stowage provisions for required safety equipment must be marked for the benefit of occupants.

523.1563 *Airspeed Placards*

There must be an airspeed placard in clear view of the pilot and as close as practicable to the airspeed indicator. This placard must list:

(a) The operating manoeuvring speed, V_O; and

(b) The maximum landing gear operating speed V_{LO}.

(c) For reciprocating multi-engine-powered aeroplanes of more than 6,000 pounds maximum weight, and turbine engine-powered aeroplanes, the maximum value of the minimum control speed, V_{MC} (one-engine-inoperative) determined under 523.149(b).

(Change 523-4 (96-09-01))
(Change 523-5)

523.1567 *Flight Manoeuvre Placard*

(a) For normal category aeroplanes, there must be a placard in front of and in clear view of the pilot stating: "No aerobatic manoeuvres, including spins, approved".

(b) For utility category aeroplanes, there must be:

(1) A placard in clear view of the pilot stating: "Aerobatic manoeuvres are limited to the following ......" (list approved manoeuvres and the recommended entry speed for each); and

(2) For those aeroplanes that do not meet the spin requirements for aerobatic category aeroplanes, an additional placard in clear view of the pilot stating: "Spins Prohibited".

(c) For aerobatic category aeroplanes, there must be a placard in clear view of the pilot listing the approved aerobatic manoeuvres and the recommended entry airspeed for each. If inverted flight manoeuvres are not approved, the placard must bear a notation to this effect.

(d) For aerobatic category aeroplanes and utility category aeroplanes approved for spinning, there must be a placard in clear view of the pilot:

(1) Listing the control actions for recovery from spinning manoeuvres; and

(2) Stating that recovery must be initiated when spiral characteristics appear, or after not more than six turns or not more than any greater number of turns for which the aeroplane has been certificated.

(Change 523-5)

Aeroplane Flight Manual and Approved Manual Material

523.1581 *General*

(a) *Furnishing information.* An Aeroplane Flight Manual must be furnished with each aeroplane, and it must contain the following:

(1) Information required by 523.1583 through 523.1589.

(2) Other information that is necessary for safe operation because of design, operating, or handling characteristics.

(3) Further information necessary to comply with the relevant operating rules.

(b) Approved information.

(1) Except as provided in paragraph (b)(2) of this section, each part of the Aeroplane Flight Manual containing information prescribed in 523.1583 through 523.1589 must be approved, segregated, identified and clearly distinguished from each unapproved part of that Aeroplane Flight Manual.

(2) The requirements of paragraph (b)(1) of this section do not apply to reciprocating engine-powered aeroplanes of 6,000 pounds or less maximum weight, if the following is met:

(i) Each part of the Aeroplane Flight Manual containing information prescribed in 523.1583 must be limited to such information, and must be approved, identified, and clearly distinguished from each other part of the Aeroplane Flight Manual.

(ii) The information prescribed in 523.1585 through 523.1589 must be determined in accordance with the applicable requirements of this Chapter and presented in its entirety in a manner acceptable to the Minister.

(3) Each page of the Aeroplane Flight Manual containing information prescribed in this section must be of a type that is not easily erased, disfigured, or misplaced, and is capable of being inserted in a manual provided by the applicant, or in a folder, or in any other permanent binder.

(c) The units used in the Aeroplane Flight Manual must be the same as those marked on the appropriate instruments and placards.

(d) All Aeroplane Flight Manual operational airspeeds, unless otherwise specified, must be presented as indicated airspeeds.

(e) Provision must be made for stowing the Aeroplane Flight Manual in a suitable fixed container which is readily accessible to the pilot.

(f) *Revisions and Amendments.* Each Aeroplane Flight Manual (AFM) must contain a means for recording the incorporation of revisions and amendments.

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

523.1583 *Operating Limitations*

The Aeroplane Flight Manual must contain operating limitations determined under this Chapter 523, including the following:

(a) *Airspeed limitations.* The following information must be furnished:

(1) Information necessary for the marking of the airspeed limits on the indicator as required in 523.1545, and the significance of each of those limits and of the colour coding used on the indicator.

(2) The speeds V_{MC}, V_O, V_{LE}, and V_{LO}, if established, and their significance.

(3) In addition, for turbine powered commuter category aeroplanes:

(i) The maximum operating limit speed, V_{MO}/M_{MO} and a statement that this speed must not be deliberately exceeded in any regime of flight (climb, cruise or descent) unless a higher speed is authorized for flight test or pilot training;

(ii) If an airspeed limitation is based upon compressibility effects, a statement to this effect and information as to any symptoms, the probable behaviour of the aeroplane, and the recommended recovery procedures; and

(iii) The airspeed limits must be shown in terms of V_{MO}/M_{MO} instead of V_{NO} and V_{NE}.

(b) *Powerplant limitations.* The following information must be furnished:

(1) Limitations required by 523.1521.

(2) Explanation of the limitations, when appropriate.

(3) Information necessary for marking the instruments required by 523.1549 through 523.1553.

(c) *Weight.* The Aeroplane Flight Manual must include:

(1) The maximum weight; and

(2) The maximum landing weight, if the design landing weight selected by the applicant is less than the maximum weight.

(3) For normal, utility, and aerobatic category reciprocating engine-powered aeroplanes of more than 6,000 pounds maximum weight and for turbine engine-powered aeroplanes in the normal, utility, and aerobatic category, performance operating limitations as follows:

(i) The maximum takeoff weight for each airport altitude and ambient temperature within the range selected by the applicant at which the aeroplane complies with the climb requirements of 523.63(c)(1).

(ii) The maximum landing weight for each airport altitude and ambient temperature within the range selected by the applicant at which the aeroplane complies with the climb requirements of 523.63(c)(2).

(4) For commuter category aeroplanes, the maximum take-off weight for each airport altitude and ambient temperature within the range selected by the applicant at which:

(i) The aeroplane complies with the climb requirements of 523.63(d)(1); and

(ii) The accelerate-stop distance determined under 523.55 is equal to the available runway length plus the length of any stopway, if utilized; and either:

(iii) The take-off distance determined under 523.59(a) is equal to the available runway length; or

(iv) At the option of the applicant, the takeoff distance determined under 523.59(a) is equal to the available runway length plus the length of any clearway and the takeoff run determined under 523.59(b) is equal to the available runway length.

(5) For commuter category aeroplanes, the maximum landing weight for each airport altitude within the range selected by the applicant at which:

(i) The aeroplane complies with the climb requirements of 523.63(d)(2) for ambient temperatures within the range selected by the applicant; and

(ii) The landing distance determined under 523.75 for standard temperatures is equal to the available runway length.

(6) The maximum zero wing fuel weight, where relevant, as established in accordance with 523.343.

(d) *Centre of gravity*. The established centre of gravity limits.

(e) *Manoeuvres*. The following authorized manoeuvres, appropriate airspeed limitations, and unauthorized manoeuvres, as prescribed in this section.

(1) *Normal category aeroplanes*. No aerobatic manoeuvres, including spins, are authorized.

(2) *Utility category aeroplanes*. A list of authorized manoeuvres demonstrated in the type flight tests, together with recommended entry speeds and any other associated limitations. No other manoeuvre is authorized.

(3) *Aerobatic category aeroplanes*. A list of approved flight manoeuvres demonstrated in the type flight tests, together with recommended entry speeds and any other associated limitations.

(4) Aerobatic category aeroplanes and utility category aeroplanes approved for spinning. Spin recovery procedure established to show compliance with 523.221(c).

(5) Commuter category aeroplanes. Manoeuvres are limited to any manoeuvre incident to normal flying, stalls, (except whip stalls) and steep turns in which the angle of bank is not more than 60 degrees.

(f) *Manoeuvre load factor*. The positive limit load factors in g's, and, in addition, the negative limit load factor for aerobatic category aeroplanes.

(g) *Minimum flight crew*. The number and functions of the minimum flight crew determined under 523.1523.

(h) *Kinds of operation*. A list of the kinds of operation to which the aeroplane is limited or from which it is prohibited under 523.1525, and also a list of installed equipment that affects any operating limitation and identification as to the equipment's required operational status for the kinds of operation for which approval has been given.

(i) *Maximum operating altitude*. The maximum altitude established under 523.1527.

(j) *Maximum passenger seating configuration.* The maximum passenger seating configuration.

(k) *Allowable lateral fuel loading.* The maximum allowable lateral fuel loading differential, if less than the maximum possible.

(l) *Baggage and cargo loading.* The following information for each baggage and cargo compartment or zone:

(1) The maximum allowable load; and

(2) The maximum intensity of loading.

(m) *Systems.* Any limitations on the use of aeroplane systems and equipment.

(n) *Ambient temperatures.* Where appropriate, maximum and minimum ambient air temperatures for operation.

(o) *Smoking.* Any restrictions on smoking in the aeroplane.

(p) *Types of surface.* A statement of the types of surface on which operations may be conducted. (See 523.45(g) and 523.1587(a)(4), (c)(2), and (d)(4)).

(Change 523-1 (88-01-01))
(Change 523-4 (96-09-01))
(Change 523-5)

523.1585 *Operating Procedures*

(a) For all aeroplanes, information concerning normal, abnormal (if applicable), and emergency procedures and other pertinent information necessary for safe operation and the achievement of the scheduled performance must be furnished, including:

(1) An explanation of significant or unusual flight or ground handling characteristics;

(2) The maximum demonstrated values of crosswind for takeoff and landing, and procedures and information pertinent to operations in crosswinds;

(3) A recommended speed for flight in rough air. This speed must be chosen to protect against the occurrence, as a result of gusts, of structural damage to the aeroplane and loss of control (for example, stalling);

(4) Procedures for restarting any turbine engine in flight, including the effects of altitude; and

(5) Procedures, speeds, and configuration(s) for making a normal approach and landing, in accordance with 523.73 and 523.75, and a transition to the balked landing condition.

(6) For seaplanes and amphibians, water handling procedures and the demonstrated wave height.

(b) In addition to paragraph (a) of this section, for all single-engine aeroplanes, the procedures, speeds, and configuration(s) for a glide following engine failure, in accordance with 523.71 and the subsequent forced landing, must be furnished.

(c) In addition to paragraph (a) of this section, for all multi-engine aeroplanes, the following information must be furnished:

(1) Procedures, speeds, and configuration(s) for making an approach and landing with one engine inoperative;

(2) Procedures, speeds, and configuration(s) for making a balked landing with one engine inoperative and the conditions under which a balked landing can be performed safely, or a warning against attempting a balked landing;

(3) The V_{SSE} determined in 523.149.

(4) Procedures for restarting any engine in flight including the effects of altitude.

(d) In addition to paragraphs (a) and either (b) or (c) of this section, as appropriate, for all normal, utility, and aerobatic category aeroplanes, the following information must be furnished:

(1) Procedures, speeds, and configuration(s) for making a normal takeoff, in accordance with 523.51(a) and (b), and 523.53(a) and (b), and the subsequent climb, in accordance with 523.65 and 523.69(a).

(2) Procedures for abandoning a takeoff due to engine failure or other cause.

(e) In addition to paragraphs (a), (c), and (d) of this section, for all normal, utility, and aerobatic category multi-engine aeroplanes, the information must include the following:

(1) Procedures and speeds for continuing a takeoff following engine failure and the conditions under which take-off can safely be continued, or a warning against attempting to continue the take-off.

(2) Procedures, speeds, and configurations for continuing a climb following engine failure, after takeoff, in accordance with 523.67, or enroute, in accordance with 523.69(b).

(f) In addition to paragraphs (a) and (c) of this section, for commuter category aeroplanes, the information must include the following:

(1) Procedures, speeds, and configuration(s) for making a normal takeoff.

(2) Procedures and speeds for carrying out an accelerate-stop in accordance with 523.55.

(3) Procedures and speeds for continuing a takeoff following engine failure in accordance with 523.59(a)(1) and for following the flight path determined under 523.57 and 523.61(a).

(g) For multi-engine aeroplanes, information identifying each operating condition in which the fuel system independence prescribed in 523.953 is necessary for safety must be furnished, together with instructions for placing the fuel system in a configuration used to show compliance with that section.

(h) For each aeroplane showing compliance with 523.1353(g)(2) or (g)(3), the operating procedures for disconnecting the battery from its charging source must be furnished.

(i) Information on the total quantity of useable fuel for each fuel tank, and the effect on the useable fuel quantity, as a result of a failure of any pump, must be furnished.

(j) Procedures for the safe operation of the aeroplane's systems and equipment, both in normal use and in the event of malfunction, must be furnished.

(Change 523-1 (88-01-01))

(Change 523-4 (96-09-01))

(Change 523-5)

523.1587 *Performance Information*

Unless otherwise prescribed, performance information must be provided over the altitude and temperature ranges required by 523.45(b).

(a) For all aeroplanes, the following information must be furnished:

(1) The stalling speeds V_{SO} and V_{S1} with the landing gear and wing flaps retracted, determined at maximum weight under 523.49, and the effect on these stalling speeds of angles of bank up to 60 degrees;

(2) The steady rate and gradient of climb with all engines operating, determined under 523.69(a);

(3) The landing distance, determined under 523.75 for each airport altitude and standard temperature, and the type of surface for which it is valid;

(4) The effect on landing distances of operation on other than smooth hard surfaces, when dry, determined under 523.45(g); and

(5) The effect on landing distances of runway slope and 50 percent of the headwind component and 150 percent of the tailwind component.

(b) In addition to paragraph (a) of this section, for all normal, utility, and aerobatic category reciprocating engine-powered aeroplanes of 6,000 pounds or less maximum weight, the steady angle of climb/descent, determined under 523.77(a), must be furnished.

(c) In addition to paragraphs (a) and (b) of this section, if appropriate, for normal, utility, and aerobatic category aeroplanes, the following information must be furnished:

(1) The takeoff distance, determined under 523.53 and the type of surface for which it is valid.

(2) The effect on takeoff distance of operation on other than smooth hard surfaces, when dry, determined under 523.45(g);

(3) The effect on takeoff distance of runway slope and 50 percent of the headwind component and 150 percent of the tailwind component;

(4) For multi-engine reciprocating engine-powered aeroplanes of more than 6,000 pounds maximum weight and multi-engine turbine powered aeroplanes, the one-engine-inoperative take-off climb/descent gradient, determined under 523.66;

(5) For multi-engine aeroplanes, the enroute rate and gradient of climb/descent with one engine inoperative, determined under 523.69(b); and

(6) For single-engine aeroplanes, the glide performance determined under 523.71.

(d) In addition to paragraph (a) of this section, for commuter category aeroplanes, the following information must be furnished:

(1) The accelerate-stop distance determined under 523.55;

(2) The takeoff distance determined under 523.59(a);

(3) At the option of the applicant, the takeoff run determined under 523.59(b);

(4) The effect on accelerate-stop distance, takeoff distance and, if determined, takeoff run, of operation on other than smooth hard surfaces, when dry, determined under 523.45(g);

(5) The effect on accelerate-stop distance, takeoff distance, and if determined, takeoff run, of runway slope and 50 percent of the headwind component and 150 percent of the tailwind component;

(6) The net takeoff flight path determined under 523.61(b);

(7) The enroute gradient of climb/descent with one engine inoperative, determined under 523.69(b);

(8) The effect, on the net takeoff flight path and on the enroute gradient of climb/descent with one engine inoperative, of 50 percent of the headwind component and 150 percent of the tailwind component;

(9) Overweight landing performance information (determined by extrapolation and computed for the range of weights between the maximum landing and maximum takeoff weights) as follows:

(i) The maximum weight for each airport altitude and ambient temperature at which the aeroplane complies with the climb requirements of 523.63(d)(2); and

(ii) The landing distance determined under 523.75 for each airport altitude and standard temperature.

(10) The relationship between IAS and CAS determined in accordance with 523.1323(b) and (c).

(11) The altimeter system calibration required by 523.1325(e).

(Change 523-1 (88-01-01))
(Change 523-3 (92-01-02))
(Change 523-4 (96-09-01))
(Change 523-5)

523.1589 *Loading Information*

The following loading information must be furnished:

(a) The weight and location of each item of equipment that can be easily removed, relocated, or replaced and that is installed when the aeroplane was weighed under the requirement of 523.25.

(b) Appropriate loading instructions for each possible loading condition between the maximum and minimum weights established under 523.25, to facilitate the centre of gravity remaining within the limits established under 523.23.

(Change 523-4 (96-09-01))

(Change 523-5)

APPENDIX A
SIMPLIFIED DESIGN LOAD CRITERIA

A523.1 *General*

(a) The design load criteria in this Appendix are an approved equivalent of those in 523.321 through 523.459 of this subchapter for an aeroplane having a maximum weight of 6,000 pounds or less and the following configuration:

(1) A single engine excluding turbine powerplants;

(2) A main wing located closer to the aeroplane's centre of gravity than to the aft, fuselage-mounted, empennage;

(3) A main wing that contains a quarter-chord sweep angle of not more than 15 degrees fore or aft;

(4) A main wing that is equipped with trailing-edge controls (ailerons or flaps, or both);

(5) A main wing aspect ratio not greater than 7;

(6) A horizontal tail aspect ratio not greater than 4;

(7) A horizontal tail volume coefficient not less than 0.34;

(8) A vertical tail aspect ratio not greater than 2;

(9) A vertical tail platform area not greater than 10 percent of the wing platform area; and

(10) Symmetrical airfoils must be used in both the horizontal and vertical tail designs.

(b) Appendix A criteria may not be used on any aeroplane configuration that contains any of the following design features:

(1) Canard, tandem-wing, close-coupled, or tailless arrangements of the lifting surfaces;

(2) Biplane or multiplane wing arrangements;

(3) T-tail, V-tail, or cruciform-tail (+) arrangements;

(4) Highly-swept wing platform (more than 15-degrees of sweep at the quarter-chord), delta planforms, or slatted lifting surfaces; or

(5) Winglets or other wing tip devices, or outboard fins.

(Change 523-5)

A523.3 *Special Symbols*

$\mathbf{n_1}$ = Aeroplane Positive Manoeuvring Limit Load Factor.

$\mathbf{n_2}$ = Aeroplane Negative Manoeuvring Limit Load Factor.

$\mathbf{n_3}$ = Aeroplane Positive Gust Limit Load Factor at V_C.

$\mathbf{n_4}$ = Aeroplane Negative Gust Limit Load Factor at V_C.

$\mathbf{n_{flap}}$ = Aeroplane Positive Limit Load Factor With Flaps Fully Extended at V_F.

* $\mathbf{V_{F\ min}}$ = Minimum Design Flap Speed = $11.0\sqrt{n_l\ W/S}$ kts.

* $\mathbf{V_{A\ min}}$ = Minimum Design Manoeuvring Speed = $15.0\sqrt{n_l\ W/S}$ kts.

* $\mathbf{V_{C\ min}}$ = Minimum Design Cruising Speed = $17.0\sqrt{n_l\ W/S}$ kts.

* $\mathbf{V_{D\ min}}$ = Minimum Design Dive Speed = $24.0\sqrt{n_l\ W/S}$ kts.

** Also see paragraph A523.7(e)(2) of this Appendix.*

A523.5 *Approval in More Than One Category*

The criteria in this Appendix may be used for certification in the normal, utility, and aerobatic categories, or in any combination of these categories. If certification in more than one category is desired, the design category weights must be selected to make the term "$n_l W$" constant for all categories or greater for one desired category than for others. The wings and control surfaces (including wing flaps and tabs) need only be investigated for the maximum value of "$n_l W$", for the category corresponding to the maximum design weight, where "$n_l W$" is constant. If the aerobatic category is selected, a special unsymmetrical flight load investigation in accordance with subparagraphs A523.9(c)(2) and A523.11(c)(2) of this Appendix must be completed. The wing, wing carry-through, and the horizontal tail structures must be checked for this condition. The basic fuselage structure need only be investigated for the highest load factor design category selected. The local supporting structure for dead weight items need only be designed for the highest load factor imposed when the particular items are installed in the aeroplane. The engine mount, however, must be designed for a higher side load factor, if certification in the aerobatic category is desired, than that required for certification in the normal and utility categories. When designing for landing loads, the landing gear and the aeroplane as a whole need only be investigated for the category corresponding to the maximum design weight. These simplifications apply to single engine aircraft of conventional types for which experience is available, and the Minister may require additional investigations for aircraft with unusual design features.

A523.7 *Flight Loads*

(a) Each flight load may be considered independent of altitude and, except for the local supporting structure for dead weight items, only the maximum design weight conditions must be investigated.

(b) Table Al and Figures A3 and A4 of this Appendix must be used to determine values of n_1, n_2, n_3, and n_4, corresponding to the maximum design weights in the desired categories.

(c) Figures Al and A2 of this Appendix must be used to determine values of n_3 and n_4 corresponding to the minimum flying weights in the desired categories, and, if these load factors are greater than the load factors at the design weight, the supporting structure for dead weight items must be substantiated for the resulting higher load factors.

(d) Each specified wing and tail loading is independent of the centre of gravity range. The applicant, however, must select a c.g. range, and the basic fuselage structure must be investigated for the most adverse dead weight loading conditions for the c.g. range selected.

(e) The following loads and loading conditions are the minimums for which strength must be provided in the structure:

(1) *Aeroplane equilibrium.* The aerodynamic wing loads may be considered to act normal to the relative wind, and to have a magnitude of 1.05 times the aeroplane normal loads (as determined from paragraphs A523.9(b) and (c) of this Appendix) for the positive flight conditions and a magnitude equal to the aeroplane normal loads for the negative conditions. Each chordwise and normal component of this wing load must be considered.

(2) *Minimum design airspeeds.* The minimum design airspeeds may be chosen by the applicant except that they may not be less than the minimum speeds found by using Figure A3 of this Appendix. In addition, V_{Cmin} need not exceed values of 0.9 V_H actually obtained at sea level for the lowest design weight category for which certification is desired. In computing these minimum design airspeeds, n_1 may not be less than 3.8.

(3) *Flight load factor.* The limit flight load factors specified in Table Al of this Appendix represent the ratio of the aerodynamic force component (acting normal to the assumed longitudinal axis of the aeroplane) to the weight of the aeroplane. A positive flight load factor is an aerodynamic force acting upward, with respect to the aeroplane.

A523.9 *Flight Conditions*

(a) *General.* Each design condition in paragraphs (b) and (c) of this section must be used to assure sufficient strength for each condition of speed and load factor on or within the boundary of a V-n diagram for the aeroplane similar to the diagram in Figure A4 of this Appendix. This diagram must also be used to determine the aeroplane structural operating limitations as specified in 523.1505 through 523.1511 and 523.1519.

(b) *Symmetrical flight conditions.* The aeroplane must be designed for symmetrical flight conditions as follows:

(1) The aeroplane must be designed for at least the four basic flight conditions, "A", "D", "E", and "G" as noted on the flight envelope of Figure A4 of this Appendix. In addition, the following requirements apply:

(i) The design limit flight load factors corresponding to conditions "D" and "E" of Figure A4 must be at least as great as those specified in Table Al and Figure A4 of

this Appendix, and the design speed for these conditions must be at least equal to the value of V_D found from Figure A3 of this Appendix.

(ii) For conditions "A" and "G" of Figure A4, the load factors must correspond to those specified in Table Al of this Appendix, and the design speeds must be computed using these load factors with the maximum static lift coefficient C_{NA} determined by the applicant. However, in the absence of more precise computations, these latter conditions may be based on a value of $C_{NA} = \pm 1.35$ and the design speed for condition "A" may be less than V_{Amin}.

(iii) Conditions "C" and "F" of Figure A4 need only be investigated when n_3W/S or n_4W/S are greater than n_1W/S or n_2W/S of this Appendix, respectively.

(2) If flaps or other high lift devices intended for use at the relatively low airspeed of approach, landing, and takeoff, are installed, the aeroplane must be designed for the two flight conditions corresponding to the values of limit flap-down factors specified in Table Al of this Appendix with the flaps fully extended at not less than the design flap speed V_{Fmin} from Figure A3 of this Appendix.

(c) *Unsymmetrical flight conditions*. Each affected structure must be designed for unsymmetrical loadings as follows:

(1) The aft fuselage-to-wing attachment must be designed for the critical vertical surface load determined in accordance with subparagraphs A523.11(c)(1) and (2) of this Appendix.

(2) The wing and wing carry-through structures must be designed for 100 percent of condition "A" loading on one side of the plane of symmetry and 70 percent on the opposite side for certification in the normal and utility categories, or 60 percent on the opposite side for certification in the aerobatic category.

(3) The wing and wing carry-through structures must be designed for the loads resulting from a combination of 75 percent of the positive manoeuvring wing loading on both sides of the plane of symmetry and the maximum wing torsion resulting from aileron displacement. The effect of aileron displacement on wing torsion at V_C or V_A using the basic airfoil moment coefficient modified over the aileron portion of the span, must be computed as follows:

(i) $C_m = C_m + 0.01\delta_u$ (up aileron side) wing basic airfoil.

(ii) $C_m = C_m - 0.01\delta_d$ (down aileron side) wing basic airfoil, where δ_u is the up aileron deflection and δ_d is the down aileron deflection.

(4) Δ critical, which is the sum of $\delta_u+\delta_d$ must be computed as follows:

(i) Compute Δ_a and Δ_b from the formulas:

$$\Delta_a = \frac{V_A}{V_C} x\ \Delta_p \text{ and } \Delta_b = 0.5 \frac{V_A}{V_D} x\ \Delta_p$$

where: Δ_p = the maximum total deflection (sum of both aileron deflections) at

V_A with V_A, V_C, and V_D described in subparagraph (2) of A523.7 (e) of this Appendix.

(ii) Compute K from the formula:

$$K = \frac{(C_m - 0.01\,\delta_b)V_D^2}{(C_m - 0.01\,\delta_a)V_C^2}$$

where δ_a is the down aileron deflection corresponding to Δ_a and δ_b is the down aileron deflection corresponding to Δ_b as computed in step (i).

(iii) If K is less than 1.0, Δ_a is Δ critical and must be used to determine δ_u and δ_d. In this case, V_C is the critical speed which must be used in computing the wing torsion loads over the aileron span.

(iv) If K is equal to or greater than 1.0, Δ_b is Δ critical and must be used to determine δ_u and δ_d. In this case, V_D is the critical speed which must be used in computing the wing torsion loads over the aileron span.

(d) Supplementary conditions; rear lift truss; engine torque; side load on engine mount. Each of the following supplementary conditions must be investigated:

(1) In designing the rear lift truss, the special condition specified in 523.369 may be investigated instead of condition "G" of Figure A4 of this Appendix. If this is done, and if certification in more than one category is desired, the value of W/S used in the formula appearing in 523.369 must be that for the category corresponding to the maximum gross weight.

(2) Each engine mount and its supporting structures must be designed for the maximum limit torque corresponding to METO power and propeller speed acting simultaneously with the limit loads resulting from the maximum positive manoeuvring flight load factor n_1. The limit torque must be obtained by multiplying the mean torque by a factor of 1.33 for engines with five or more cylinders. For 4, 3, and 2 cylinder engines, the factor must be 2, 3, and 4 respectively.

(3) Each engine mount and its supporting structure must be designed for the loads resulting from a lateral limit load factor of not less than 1.47 for the normal and utility categories, or 2.0 for the aerobatic category.

A523.11 *Control Surface Loads*

(a) *General.* Each control surface load must be determined using the criteria of paragraph (b) of this section and must lie within the simplified loadings of paragraph (c) of this section.

(b) *Limit pilot forces.* In each control surface loading condition described in paragraphs (c) through (e) of this section, the air loads on the movable surfaces and the corresponding deflections need not exceed those which could be obtained in flight by employing the maximum limit pilot forces specified in the table in 523.397(b). If the surface loads are limited by these maximum limit pilot forces, the tabs must either be considered to be deflected to their maximum travel in the direction which would assist the pilot or the

deflection must correspond to the maximum degree of "out of trim" expected at the speed for the condition under consideration. The tab load, however, need not exceed the value specified in Table A2 of this Appendix.

(c) *Surface loading conditions.* Each surface loading condition must be investigated as follows:

(1) Simplified limit surface loadings for the horizontal tail, vertical tail, aileron, wing flaps, and trim tabs are specified in Figures A5 and A6 of this Appendix.

(i) The distribution of load along the span of the surface, irrespective of the chord-wise load distribution, must be assumed proportional to the total chord, except on horn balance surfaces.

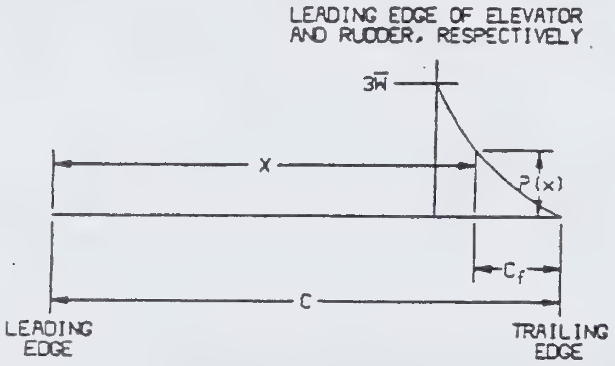
(ii) The load on the stabilizer and elevator, and the load on fin and rudder, must be distributed chord-wise as shown in Figure A7 of this Appendix.

(iii) In order to ensure adequate torsional strength and to account for manoeuvres and gusts, the most severe loads must be considered in association with every centre of pressure position between the leading edge and the half chord of the mean chord of the surface (stabilizer and elevator, or fin and rudder).

(iv) To ensure adequate strength under high leading edge loads, the most severe stabilizer and fin loads must be further considered as being increased by 50 percent over the leading 10 percent of the chord with the loads aft of this appropriately decreased to retain the same total load.

(v) The most severe elevator and rudder loads should be further considered as being distributed parabolically from three times the mean loading of the surface (stabilizer and elevator, or fin and rudder) at the leading edge of the elevator and rudder, respectively, to zero at the trailing edge according to the equation:

$$P(x)=3(\overline{w})\frac{(c-x)^2}{c_f^{\,2}}$$



Where:

P(x) = local pressure at the chord-wise stations x,

c = chord length of the tail surface,

cf = chord length of the elevator and rudder respectively, and

$\overline{w}$ = average surface loading as specified in Figure A5.

(vi) The chord-wise loading distribution for ailerons, wing flaps, and trim tabs are specified in Table A2 of this Appendix.

(2) If certification in the aerobatic category is desired, the horizontal tail must be investigated for an unsymmetrical load of 100 percent on one side of the aeroplane centreline and 50 percent on the other side of the aeroplane centreline.

(d) *Outboard fins.* Outboard fins must meet the requirements of 523.445.

(e) *Special devices.* Special devices must meet the requirements of 523.459.

(Change 523-5)

A523.13 *Control System Loads*

(a) *Primary flight controls and systems.* Each primary flight control and system must be designed as follows:

(1) The flight control system and its supporting structure must be designed for loads corresponding to 125 percent of the computed hinge moments of the movable control surface in the conditions prescribed in A523.11 of this Appendix. In addition:

(i) The system limit loads need not exceed those that could be produced by the pilot and automatic devices operating the controls; and

(ii) The design must provide a rugged system for service use, including jamming, ground gusts, taxiing downwind, control inertia, and friction.

(2) Acceptable maximum and minimum limit pilot forces for elevator, aileron, and rudder controls are shown in the table in 523.397(b). These pilot loads must be assumed to act at the appropriate control grips or pads as they would under flight conditions, and to be reacted at the attachments of the control system to the control surface horn.

(b) *Dual controls.* If there are dual controls, the systems must be designed for pilots operating in opposition, using individual pilot loads equal to 75 percent of those obtained in accordance with paragraph (a) of this section, except that individual pilot loads may not be less than the minimum pilot forces shown in the table in 523.397(b).

(c) *Ground gust conditions.* Ground gust conditions must meet the requirements of 523.415.

(d) *Secondary controls and systems.* Secondary controls and systems must meet the requirements of 523.405.

Limit Flight Load Factors					
			Normal Category	Utility Category	Aerobatic Category
Flight Load Factors	Flaps Up	n1	3.8	4.4	6.0
		n2	-0.5n1		
		n3	Find n3 from Fig. A1		
		n4	Find n4 from Fig. A2		
	Flaps Down	nflap	0.5n1		
		nflap	Zero*		
*Vertical wing load may be assumed equal to zero and only the flap part of the wing need be checked for this condition.					

Table Al - Limit Flight Load Factors

AVERAGE LIMIT CONTROL SURFACE LOADING			
SURFACE	DIRECTION OF LOADING	MAGNITUDE OF LOADING	CHORDWISE DISTRIBUTION
Horizontal Tail I	a) Up and Down	Figure A5 Curve (2)	See Figure A7
	b) Unsymmetrical Loading (Up and Down)	100% $\bar{w}$ on one side of airplane ℄ 65% $\bar{w}$ on other side of airplane ℄ for normal and utility categories. For aerobatic category see A523.11(c)	
Vertical Tail II	Right and Left	Figure A5 Curve (1)	Same as above
Aileron III	a) Up and Down	Figure A5 Curve (5)	(C) 
Wing Flap IV	a) Up	Figure A5 Curve (4)	(D) 
	b) Down	.25 x Up Load (a)	
Trim Tab V	a) Up and Down	Figure A5 Curve (3)	Same as (D) above

NOTE: The surface loading I, II, III, and V above are based on speeds V_A min and V_C min.

The loading of IV is based on V_F min.

If values of speed greater than these minimums are selected for design, the appropriate surface loadings must be multiplied by the ratio $\left(\frac{V_{selected}}{V_{minimum}}\right)^2$.

For conditions I, II, III, and V the multiplying factor used must be the higher of $\left(\frac{V_A \text{ sel.}}{V_A \text{ min.}}\right)^2$ or $\left(\frac{V_C \text{ sel.}}{V_C \text{ min.}}\right)^2$

Table A2 - Average limit control surface loading

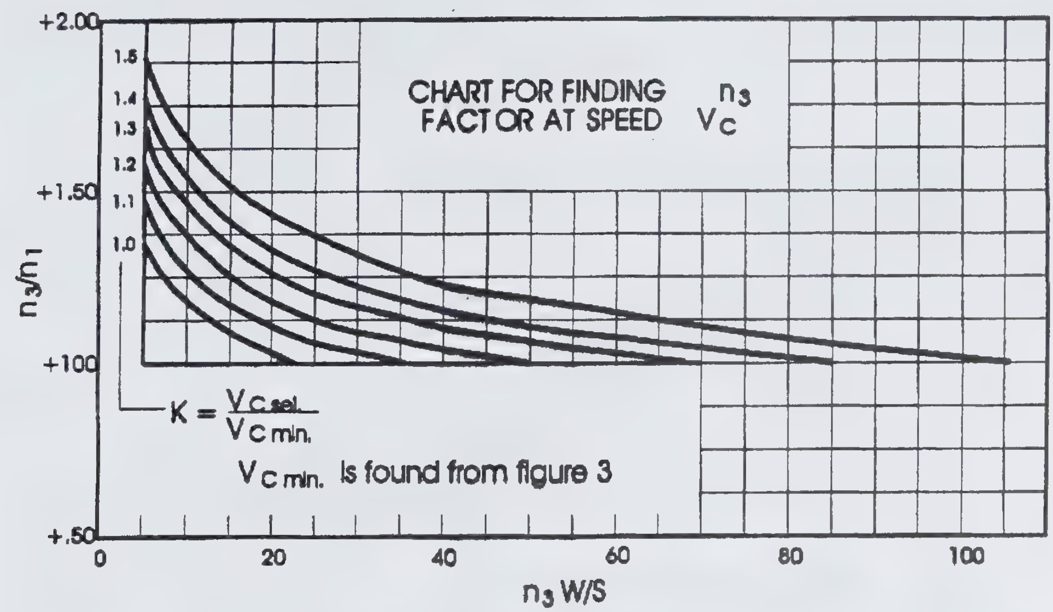


Figure A-1 Chart for finding n_3 factor at speed V_c.

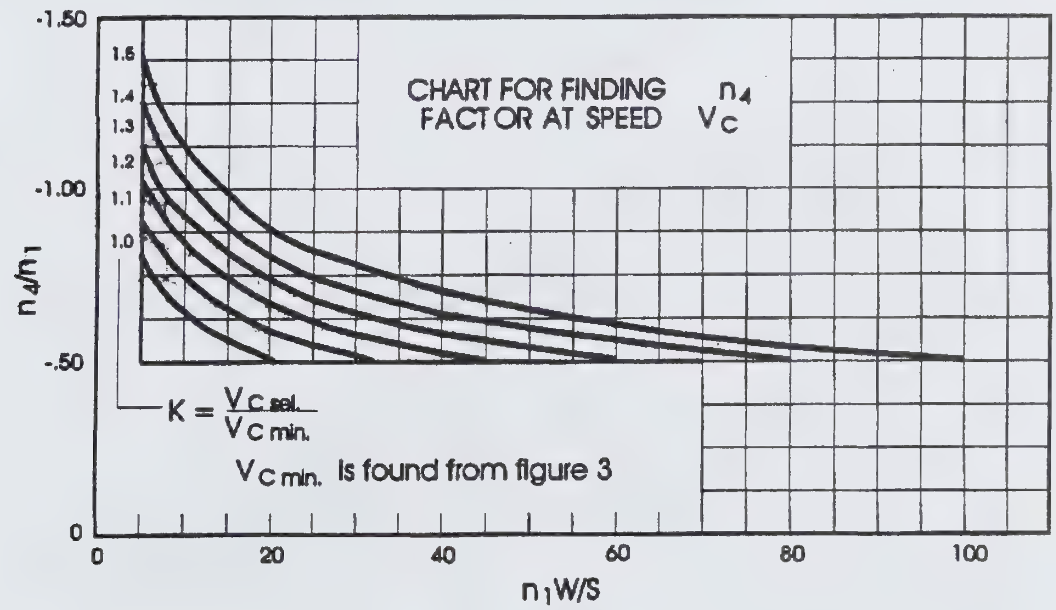


Figure A-2 Chart for finding n_4 factor at speed V_c

$V_D \text{ min} = 24.0\sqrt{\frac{n_1 W}{S}}$ but need not exceed $1.4\sqrt{\frac{n_1}{3.8}} V_C \text{ min}$

$V_C \text{ min} = 17.0\sqrt{\frac{n_1 W}{S}}$ but need not exceed o.9 V_H

$V_A \text{ min} = 15.0\sqrt{\frac{n_1 W}{S}}$ but need not exceed V_C used in design.

$V_F \text{ min} = 11.0\sqrt{\frac{n_1 W}{S}}$

Figure A3:
Determination of minimum design speeds equations Speeds are in knots

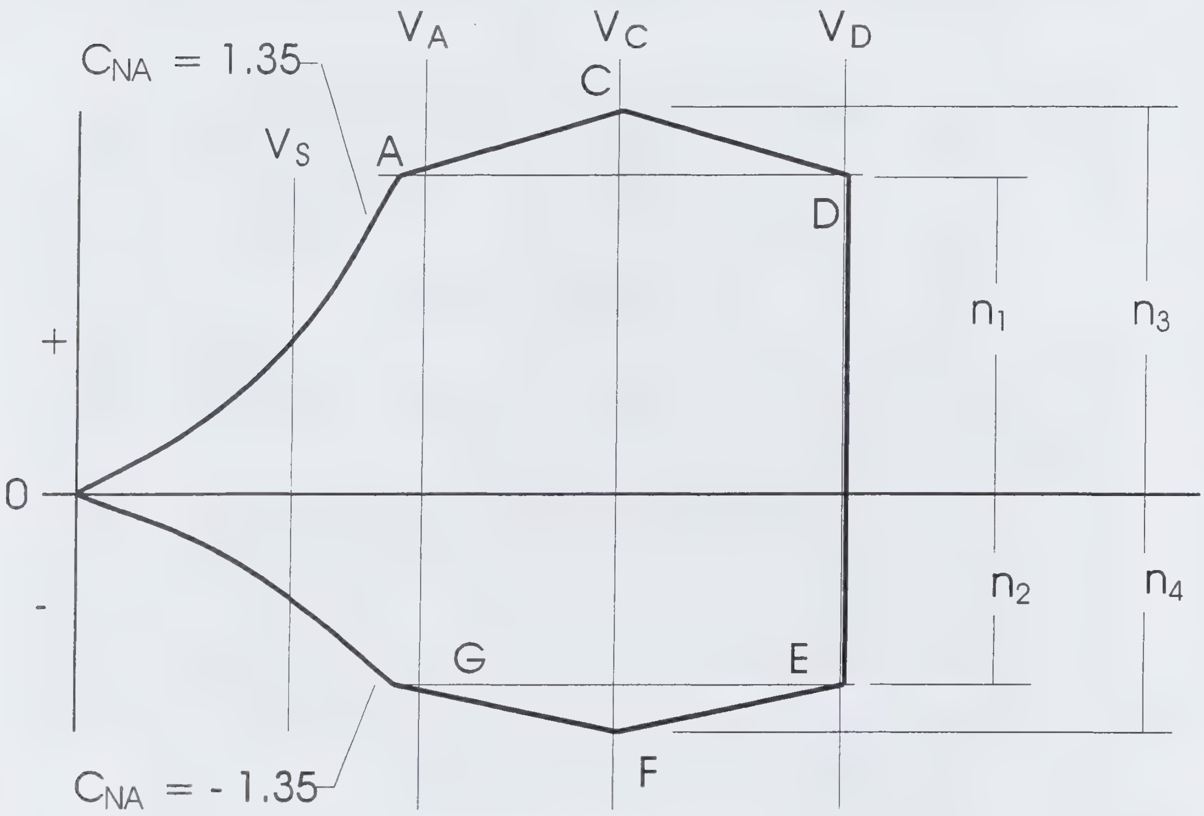


Figure A4 Flight envelope

1. Conditions *"C" or "F" need only be investigated when* $n_3\frac{W}{S}$ or $n_4\frac{W}{S}$ is greater than $n_1\frac{W}{S}$ or $n_2\frac{W}{S}$, respectively.

2. 2. *Condition "G" need not be investigated when the supplementary condition specified in 523.369 is investigated.*

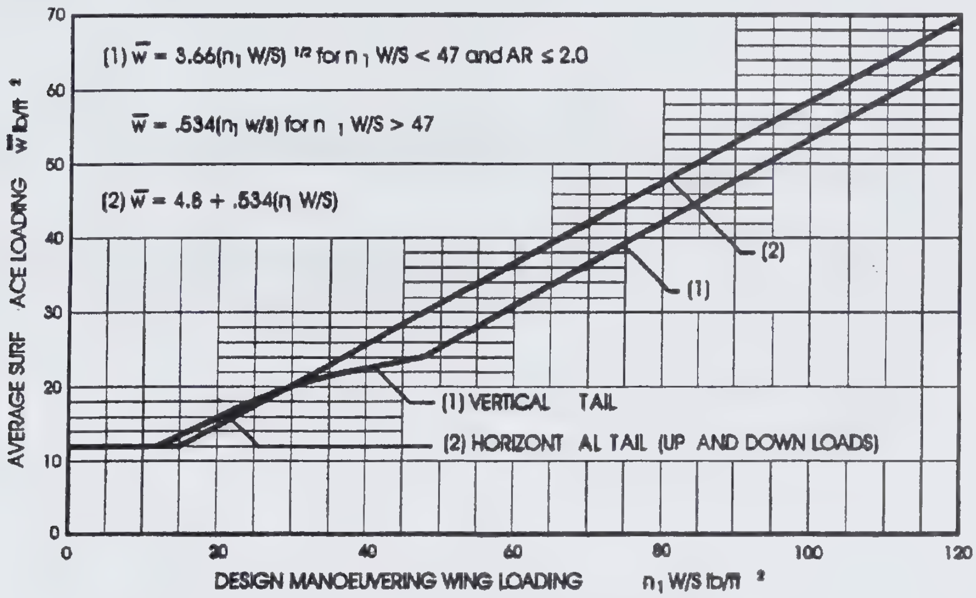


Figure A5 - Average limit control surface loading

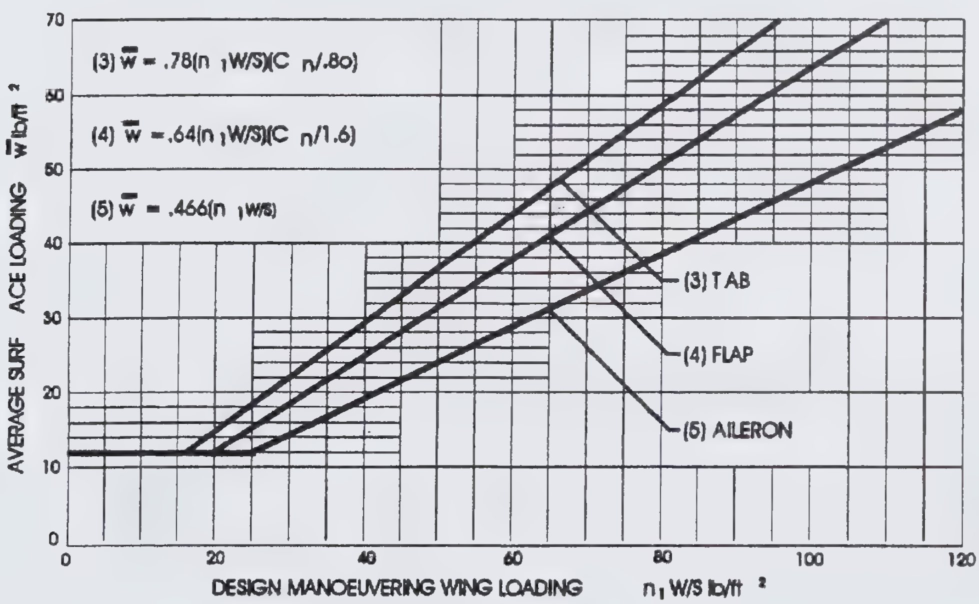


Figure A6 - Average limit control surface loading

Figure A7.—Chordwise Load Distribution for Stabilizer and Elevator or Fin and Rudder

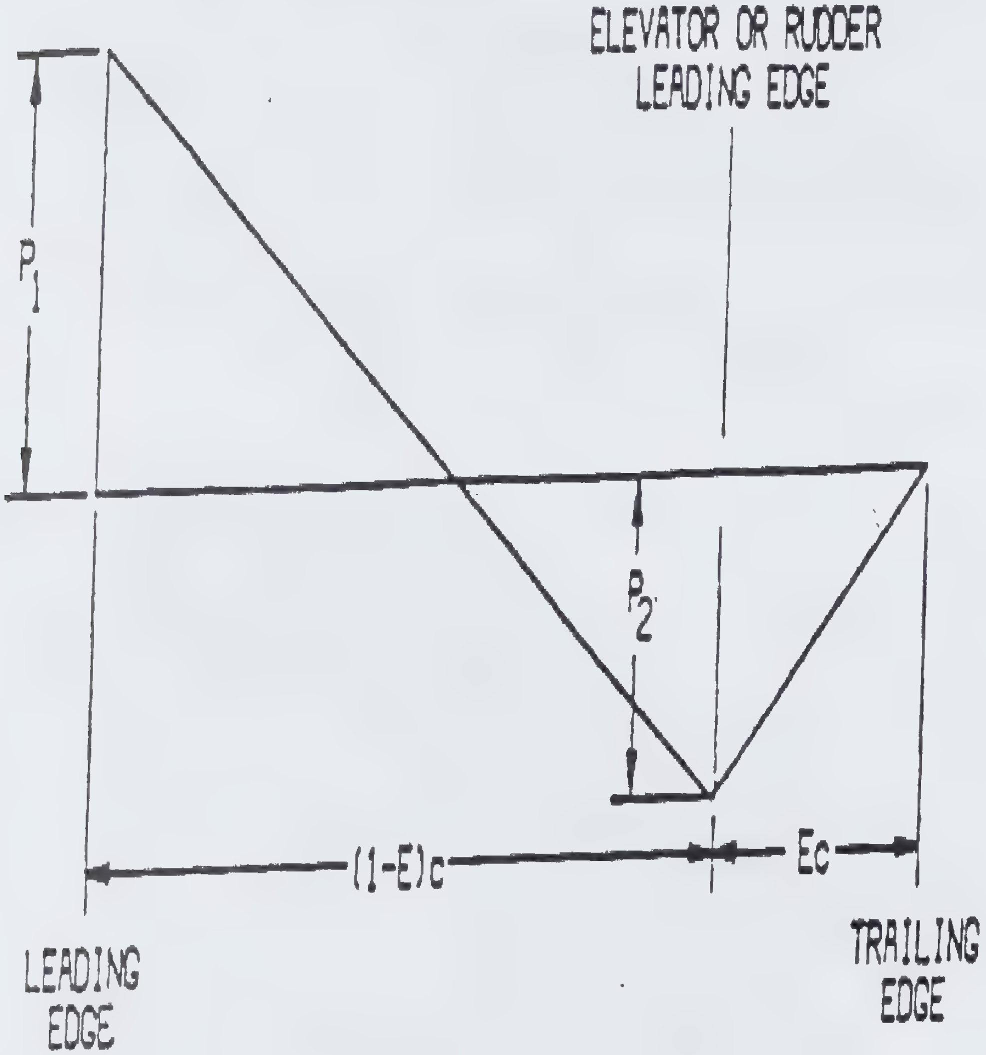


Figure A7

$$P_1 = 2(\bar{w})\frac{(2 - E - 3d')}{(1 - E)}$$

$$P_2 = 2(\bar{w})(3d' + E - 1)$$

where:

$\bar{w}$ = average surface loading (as specified in Figure A5)

E = ratio of elevator (or rudder) chord to total stabilizer and elevator (or fin and rudder) chord.

d'= ratio of distance of centre of pressure of a unit span wise length of combined stabilizer and elevator (or fin and rudder) measured from stabilizer (or fin) leading edge to the local chord. Sign convention is positive when centre of pressure is behind leading edge.

c = local chord.

Note: *Positive values of $\bar{w}$, P_1 and P_2 are all measured in the same direction.*

(Change 523-5)

APPENDIX B

Reserved

APPENDIX C
BASIC LANDING CONDITIONS

C523.1 *Basic Landing Conditions*

Condition	*Tail Wheel Type*		*Nose Wheel Type*		
	Level Landing	*Tail-Down Landing*	*Level Landing With Inclined Reactions*	*Level Landing With Nose Wheel Just Clear Of Ground*	*Tail-Down Landing*
Reference section	523.479(a)(1)	523.481(a)(1)	523.479(a)(2)(i)	523.479(a)(2)(ii)	523.481(a)(2)&(b)
Vertical component at c.g.	nW	nW	nW	nW	nW
Fore and aft component at c.g.	KnW	0	KnW	KnW	0
Lateral component in either direction at c.g.	0	0	0	0	0
Shock absorber extension (hydraulic shock absorber)	Note (2)	Note (2)	Note (2)	Note (2)	Note (2)
Shock absorber deflection (rubber or spring shock absorber), percent.	100	100	100	100	100
Tire deflection	Static	Static	Static	Static	Static
Main wheel loads (both wheels) (Vr)	(n-L)W	(n-L)W b/d	(n-L)W a′/d′	(n-L)W	(n-L)W
Main wheel loads (both wheels) (Dr)	KnW	0	KnW a′/d′	KnW	0
Tail (nose) wheel loads (Vf)	0	(n-L)W a/d	(n-L)W b′/d′	0	0
Tail (nose) wheel loads (Df)	0	0	KnW b′/d′	0	0
Notes	(1), (3), and (4)	(4)	(1)	(1), (3), and (4)	(3) and (4)

Note 1. K may be determined as follows: K=0.25 for W=3,000 pounds or less; K=0.33 for W=6,000 pounds or greater, with linear variation of K between these weights.

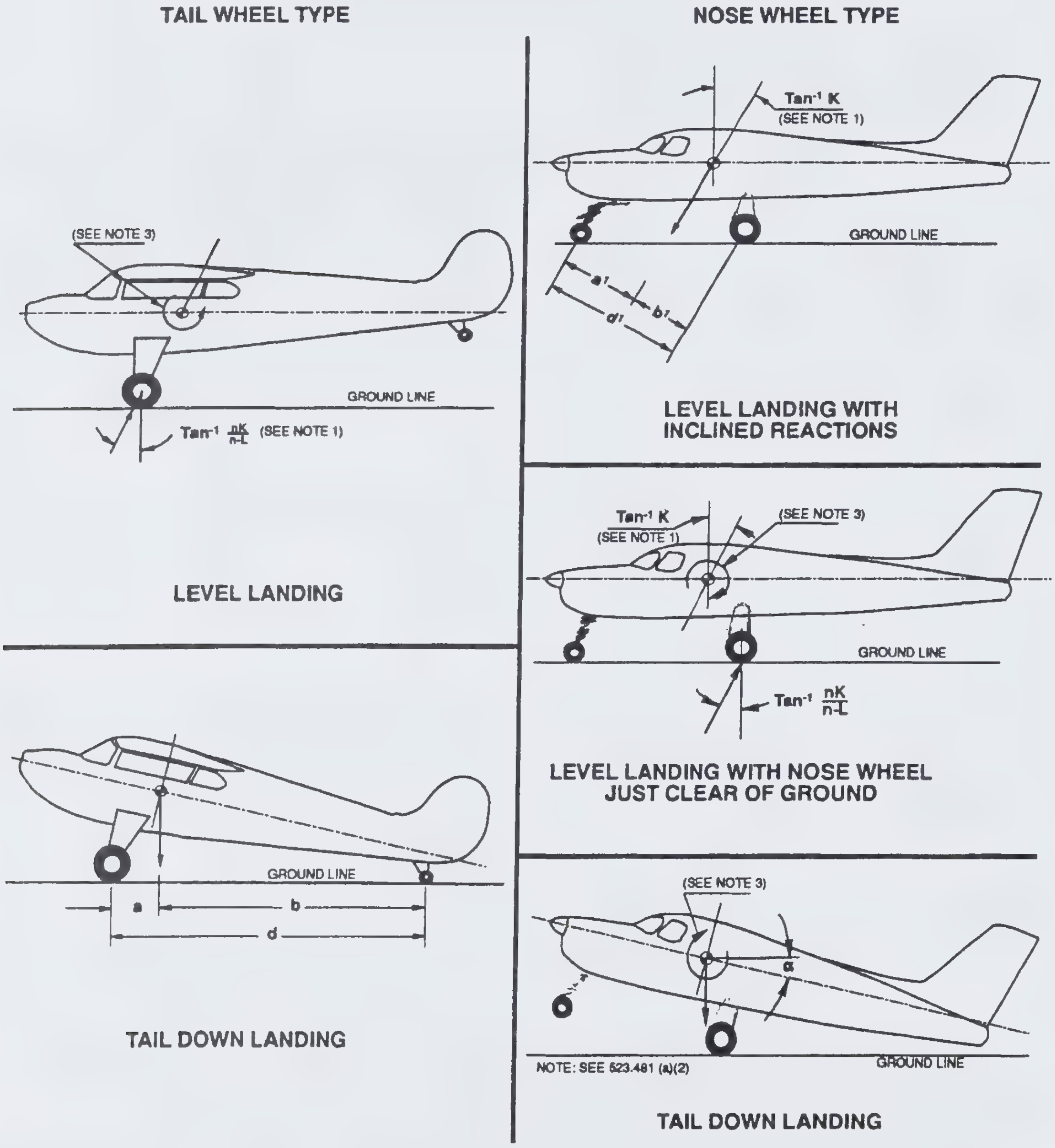
Note 2. For the purpose of design, the maximum load factor is assumed to occur throughout the shock absorber stroke from 25 percent deflection to 100 percent deflection unless otherwise shown and the load factor must be used with whatever shock absorber extension is most critical for each element of the landing gear.

Note 3. Unbalanced moments must be balanced by a rational conservative method.

Note 4. L is defined in 523.725(b).

Note 5. n is the limit inertia load factor, at the c.g. of the aeroplane, selected under 523.473(d), (f), and (g).

BASIC LANDING CONDITIONS



APPENDIX D
WHEEL SPIN-UP AND SPRING-BACK LOADS

D523.1 *Wheel Spin-up Loads*

(a) The following method for determining wheel spin-up loads for landing conditions is based on NACA T.N. 863. However, the drag component used for design may not be less than the drag load prescribed in 523.479(b).

$$F_{H\max} = \frac{1}{r_e}\frac{\sqrt{2I_w(V_H - V_C)nF_{v\max}}}{t_s}$$

where:

$\mathbf{F_{Hmax}}$ = maximum rearward horizontal force acting on the wheel (in pounds);

$\mathbf{r_e}$ = effective rolling radius of wheel under impact based on recommended operating tire pressure (which may be assumed to be equal to the rolling radius under a static load of n_jW_e) in feet;

$\mathbf{I_w}$ = rotational mass moment of inertia of rolling assembly (in slug feet);

$\mathbf{V_H}$ = linear velocity of aeroplane parallel to ground at instant of contact (assumed to be 1.2 V_{SO}, in feet per second);

V_C = peripheral speed of tire, if pre-rotation is used (in feet per second) (there must be a positive means of pre-rotation before pre-rotation may be considered);

n = effective coefficient of friction (0.80 may be used).

$\mathbf{F_{v\ max}}$ = maximum vertical force on wheel (pounds) = n_jW_e, where W_e and n_j are defined in 523.725;

$\mathbf{t_s}$ = time interval between ground contact and attainment of maximum vertical force on wheel (seconds). However, if the value of F_{Vmax}, from the above equation exceeds 0.8 F_{vmax}, the latter value must be used for F_{Hmax}.)

(b) This equation assumes a linear variation of load factor with time until the peak load is reached and under this assumption, the equation determines the drag force at the time that the wheel peripheral velocity at radius r_e equals the aeroplane velocity. Most shock absorbers do not exactly follow a linear variation of load factor with time. Therefore, rational or conservative allowances must be made to compensate for these variations. On most landing gears, the time for wheel spin-up will be less than the time required to develop maximum vertical load factor for the specified rate of descent and forward velocity. For exceptionally large wheels, a wheel peripheral velocity equal to the ground speed may not have been attained at the time of maximum vertical gear load. However, as stated above, the drag spin-up load need not exceed 0.8 of the maximum vertical loads.

(c) Dynamic spring-back of the landing gear and adjacent structure at the instant just after the wheels come up to speed may result in dynamic forward acting loads of considerable magnitude. This effect must be determined, in the level landing condition, by assuming

that the wheel spin-up loads calculated by the methods of this appendix are reversed. Dynamic spring-back is likely to become critical for landing gear units having wheels of large mass or high landing speeds.

(Change 523-4 (96-09-01))

APPENDIX E

Removed and Reserved

(Change 523-5)

APPENDIX F
TEST PROCEDURE

Acceptable test procedure for self-extinguishing materials for showing compliance with 523.853, 523.855 and 523.1359.

(a) Conditioning. Specimens must be conditioned to 70° F, plus or minus 5° , and at 50 percent plus or minus 5 percent relative humidity until moisture equilibrium is reached or for 24 hours. Only one specimen at a time may be removed from the conditioning environment immediately before subjecting it to the flame.

(b) Specimen configuration. Except as provided for materials used in electrical wire and cable insulation and in small parts, materials must be tested either as a section cut from a fabricated part as installed in the aeroplane or as a specimen simulating a cut section, such as: a specimen cut from a flat sheet of the material or a model of the fabricated part. The specimen may be cut from any location in a fabricated part; however, fabricated units, such as sandwich panels, may not be separated for a test. The specimen thickness must be no thicker than the minimum thickness to be qualified for use in the aeroplane, except that:

(1) Thick foam parts, such as seat cushions, must be tested in 1/2-inch thickness;

(2) When showing compliance with 523.853(d)(3)(v) for materials used in small parts that must be tested, the materials must be tested in no more than 1/8-inch thickness;

(3) When showing compliance with 523.1359(c) for materials used in electrical wire and cable insulation, the wire and cable specimens must be the same size as used in the aeroplane. In the case of fabrics, both the warp and fill direction of the weave must be tested to determine the most critical flammability conditions. When performing the tests prescribed in paragraphs (d) and (e) of this Appendix, the specimen must be mounted in a metal frame so that (1) in the vertical tests of paragraph (d) of this Appendix, the two long edges and the upper edge are held securely; (2) in the horizontal test of paragraph (e) of this Appendix, the two long edges and the edge away from the flame are held securely; (3) the exposed area of the specimen is at least 2 inches wide and 12 inches long, unless the actual size used in the aeroplane is smaller; and (4) the edge to which the burner flame is applied must not consist of the finished or protected edge of the specimen but must be representative of the actual cross section of the material or part installed in the aeroplane. When performing the test prescribed in paragraph (f) of this Appendix, the specimen must be mounted in metal frame so that all four edges are held securely and the exposed area of the specimen is at least 8 inches by 8 inches.

(c) Apparatus. Except as provided in paragraph (g) of this Appendix, tests must be conducted in a draft free cabinet in accordance with Federal Test Method Standard 191 Method 5903 (revised Method 5902) which is available from the United States Federal Aviation Administration General Services Administration, Business Service Centre, Region 3, Seventh and D Streets SW., Washington, D.C. 20407 (U.S.A.), or with some

other approved equivalent method. Specimens, which are too large for the cabinet, must be tested in similar draft-free conditions.

(d) Vertical test. A minimum of three specimens must be tested and the results averaged. For fabrics, the direction of weave corresponding to the most critical flammability conditions must be parallel to the longest dimension. Each specimen must be supported vertically. The specimen must be exposed to a Bunsen or Tirrill burner with a nominal 3/8-inch I.D. tube adjusted to give a flame of 1 1/2 inches in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the centre of the flame must be 1,550 F. The lower edge of the specimen must be three-fourths inch above the top edge of the burner. The flame must be applied to the centre line of the lower edge of the specimen. For materials covered by 523.853(d)(3)(i) and 523.853 (f), the flame must be applied for 60 seconds and then removed. For materials covered by 523.853(d)(3)(ii), the flame must be applied for 12 seconds and then removed. Flame time, burn length, and flaming time of drippings, if any must be recorded. The burn length determined in accordance with paragraph (h) of this Appendix must be measured to the nearest one-tenth inch.

(e) Horizontal test. A minimum of three specimens must be tested and the results averaged. Each specimen must be supported horizontally. The exposed surface when installed in the aeroplane must be face down for the test. The specimen must be exposed to a Bunsen burner or Tirrill burner with a nominal 3/8-inch I.D. tube adjusted to give a flame of 1 1/2 inches in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the centre of the flame must be 1550°F. The specimen must be positioned so that the edge being tested is three-fourths of an inch above the top of, and on the centre line of, the burner. The flame must be applied for 15 seconds and then removed. A minimum of 10 inches of the specimen must be used for timing purposes, approximately 1 1/2 inches must burn before the burning front reaches the timing zone and the average burn rate must be recorded.

(f) Forty-five degree test. A minimum of three specimens must be tested and the results averaged. The specimens must be supported at an angle of 45 degrees to a horizontal surface. The exposed surface when installed in the aircraft must be face down for the test. The specimens must be exposed to a Bunsen or Tirrill burner with a nominal 3/8 inch I.D. tube adjusted to give a flame of 11/2 inches in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the centre of the flame must be 1550° F. Suitable precautions must be taken to avoid drafts. The flame must be applied for 30 seconds with one-third contacting the material at the centre of the specimen and then removed. Flame time, glow time, and whether the flame penetrates (passes through) the specimen must be recorded.

(g) Sixty-degree test. A minimum of three specimens of each wire specification (make and size) must be tested. The specimen of wire or cable (including insulation) must be placed at an angle of 60 degrees with the horizontal in the cabinet specified in paragraph (c) of this Appendix, with the cabinet door open during the test or placed within a chamber approximately 2 feet high x 1 foot x 1 foot, open at the top and at one vertical side (front), that allows sufficient flow of air for complete combustion but is free from drafts. The

specimen must be parallel to and approximately 6 inches from the front of the chamber. The lower end of the specimen must be held rigidly clamped. The upper end of the specimen must pass over a pulley or rod and must have an appropriate weight attached to it so that the specimen is held tautly throughout the flammability test. The test specimen span between lower clamp and upper pulley or rod must be 24 inches and must be marked 8 inches from the lower end to indicate the central point for flame application. A flame from a Bunsen or Tirrill burner must be applied for 30 seconds at the test mark. The burner must be mounted underneath the test mark on the specimen, perpendicular to the specimen and at an angle of 30 degrees to the vertical plane of the specimen. The burner must have a nominal bore of three-eighths inch, and must be adjusted to provide a three-inch-high flame with an inner cone approximately one-third of the flame height. The minimum temperature of the hottest portion of the flame, as measured with a calibrated thermocouple pyrometer, may not be less than 1750° F. The burner must be positioned so that the hottest portion of the flame is applied to the test mark on the wire. Flame time, burn length, and flaming time of drippings, if any, must be recorded. The burn length determined in accordance with paragraph (h) of this Appendix must be measured to the nearest one-tenth inch. Breaking of the wire specimen is not considered a failure.

(h) Burn length. Burn length is the distance from the original edge to the farthest evidence of damage to the test specimen due to flame impingement, including areas of partial or complete consumption, charring, or embrittlement, but not including areas sooted, stained, warped, or discoloured, nor areas where material has shrunk or melted away from the heat source.

(Change 523-5)

APPENDIX G
INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

G523.1 *General*

(a) This appendix specifies requirements for the preparation of Instructions for Continued Air worthiness as required by 523.1529.

(b) The Instructions for Continued Airworthiness for each aeroplane must include the Instructions for Continued Airworthiness for each engine and propeller (hereinafter designated 'products'), for each appliance required by this Manual, and any required information relating to the interface of those appliances and products with the aeroplane. If Instructions for Continued Airworthiness are not supplied by the manufacturer of an appliance or product installed in the aeroplane, the Instructions for Continued Airworthiness for the aeroplane must include the information essential to the continued airworthiness of the aeroplane.

(c) The applicant must submit to the Minister a program to show how changes to the Instructions for Continued Airworthiness made by the applicant or by the manufacturers of products and appliances installed in the aeroplane will be distributed.

G523.2 *Format*

(a) The Instructions for Continued Airworthiness must be in the form of a manual or manuals as appropriate for the quantity of data to be provided.

(b) The format of the manual or manuals must provide for a practical arrangement.

G523.3 *Content*

The Instructions for Continued Air worthiness must contain the following manuals or sections, as appropriate, and information:

(a) Aeroplane maintenance manual or section.

(1) Introduction information that includes an explanation of the aeroplane's features and data to the extent necessary for maintenance or preventive maintenance.

(2) A description of the aeroplane and its systems and installations including its engines, propellers, and appliances.

(3) Basic control and operation information describing how the aeroplane components and systems are controlled and how they operate, including any special procedures and limitations that apply.

(4) Servicing information that covers details regarding servicing points, capacities of tanks, reservoirs, types of fluids to be used, pressures applicable to the various systems, location of access panels for inspection and servicing, locations of lubrication points, lubricants to be used, equipment required for servicing, tow instructions and limitations, mooring, jacking, and levelling information.

(b) Maintenance Instructions.

(1) Scheduling information for each part of the aeroplane and its engines, auxiliary power units, propellers, accessories, instruments, and equipment that provides the recommended periods at which they should be cleaned, inspected, adjusted, tested, and lubricated, and the degree of inspection, the applicable wear tolerances, and work recommended at these periods. However, the applicant may refer to an accessory, instrument, or equipment manufacturer as the source of this information if the applicant shows that the item has an exceptionally high degree of complexity requiring specialised maintenance techniques, test equipment, or expertise. The recommended overhaul periods and necessary cross reference to the Airworthiness Limitations section of the manual must also be included. In addition, the applicant must include an inspection program that includes the frequency and extent of the inspections necessary to provide for the continued airworthiness of the aeroplane.

(2) Troubleshooting information describing probable malfunctions, how to recognise those malfunctions, and the remedial action for those malfunctions.

(3) Information describing the order and method of removing and replacing products and parts with any necessary precautions to be taken.

(4) Other general procedural instructions including procedures for system testing during ground running, symmetry checks, weighing and determining the centre of gravity, lifting and shoring, and storage limitations.

(c) Diagrams of structural access plates and information needed to gain access for inspections when access plates are not provided.

(d) Details for the application of special inspection techniques including radiographic and ultrasonic testing where such processes are specified.

(e) Information needed to apply protective treatments to the structure after inspection.

(f) All data relative to structural fasteners such as identification, discard recommendations, and torque values.

(g) A list of special tools needed.

(h) In addition, for commuter category aeroplanes, the following information must be furnished:

(1) Electrical loads applicable to the various systems;

(2) Methods of balancing control surfaces;

(3) Identification of primary and secondary structures; and

(4) Special repair methods applicable to the aeroplane.

G523.4 *Airworthiness Limitations Section*

The Instructions for Continued Airworthiness must contain a section titled Airworthiness Limitations that is segregated and clearly distinguishable from the rest of the document. This section must set forth each mandatory replacement time, structural inspection interval, and related structural inspection procedure required for type certification. If the Instructions for Continued Airworthiness consist of multiple documents, the section required by this paragraph must be included in the principal manual. This section must contain a legible statement in a prominent location that reads: "The Airworthiness Limitations section is approved by the Minister and specifies maintenance required under any applicable airworthiness or operating rule, unless an alternative program has been approved by the Minister".

APPENDIX H
INSTALLATION OF AN AUTOMATIC POWER RESERVE (APR) SYSTEM

H523.1 *General*

(a) This Appendix specifies requirements for installation of an APR engine power control system that automatically advances power or thrust on the operating engine(s) in the event any engine fails during takeoff.

(b) With the APR system and associated systems functioning normally, all applicable requirements (except as provided in this appendix) must be met without requiring any action by the crew to increase power or thrust.

(Change 523-4 (96-09-01))

H523.2 *Definitions*

(a) *Automatic power reserve system* means the entire automatic system used only during takeoff, including all devices both mechanical and electrical that sense engine failure, transmit signals, actuate fuel controls or power levers on operating engines, including power sources, to achieve the scheduled power increase and furnish cockpit information on system operation.

(b) *Selected takeoff power,* notwithstanding the definition of "Takeoff Power" in Chapter 500 of this manual, means the power obtained from each initial power setting approved for takeoff.

(c) *Critical Time Interval*, as illustrated in Figure Hl, means that period starting at V_1 minus one second and ending at the intersection of the engine and APR failure flight path line with the minimum performance all engine flight path line. The engine and APR failure flight path line intersects the one-engine-inoperative flight path line at 400 feet above the takeoff surface. The engine and APR failure flight path is based on the aeroplane's performance and must have a positive gradient of at least 0.5 percent at 400 feet above the takeoff surface.

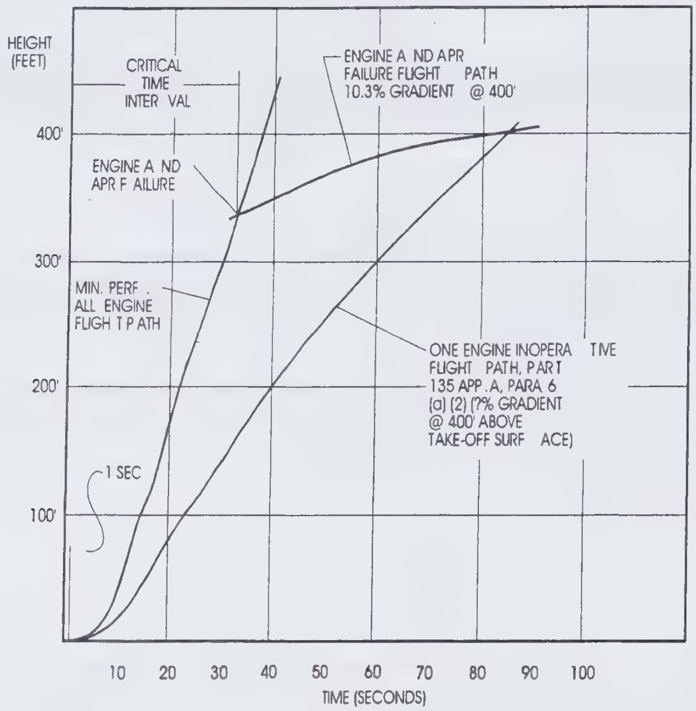


Figure Hl - Critical Time Interval Illustration

(Change 523-4 (96-09-01))

H523.3 *Reliability and Performance Requirements*

(a) It must be shown that, during the critical time interval, an APR failure that increases or does not affect power on either engine will not create a hazard to the aeroplane, or it must be shown that such failures are improbable.

(b) It must be shown that, during the critical time interval, there are no failure modes of the APR system that would result in a failure that will decrease the power on either engine or it must be shown that such failures are extremely improbable.

(c) It must be shown that, during the critical time interval, there will be no failure of the APR system in combination with an engine failure or it must be shown that such failures are extremely improbable.

(d) All applicable performance requirements must be met with an engine failure occurring at the most critical point during takeoff with the APR system functioning normally.

(Change 523-4 (96-09-01))

H523.4 *Power Setting*

The selected takeoff power set on each engine at the beginning of the takeoff roll may not be less than:

(a) The power necessary to attain, at V_1, 90 percent of the maximum takeoff power approved for the aeroplane for the existing conditions;

(b) That required to permit normal operation of all safety-related systems and equipment that are dependent upon engine power or power lever position; and

(c) That shown to be free of hazardous engine response characteristics when power is advanced from the selected takeoff power level to the maximum approved takeoff power.

(Change 523-4 (96-09-01))

H523.5 *Powerplant Controls-General*

(a) In addition to the requirements of 523.1141, no single failure or malfunction (or probable combination thereof) of the APR, including associated systems, may cause the failure of any powerplant function necessary for safety.

(b) The APR must be designed to:

(1) Provide a means to verify to the flight crew before takeoff that the APR is in an operating condition to perform its intended function;

(2) Automatically advance power on the operating engines following an engine failure during takeoff to achieve the maximum attainable takeoff power without exceeding engine operating limits;

(3) Prevent deactivation of the APR by manual adjustment of the power levers following an engine failure;

(4) Provide a means for the flight crew to deactivate the automatic function. This means must be designed to prevent inadvertent deactivation; and

(5) Allow normal manual decrease or increase in power up to the maximum takeoff power approved for the aeroplane under the existing conditions through the use of power levers, as stated in 523.1141(c), except as provided under paragraph (c) of H523.5 of this Appendix.

(c) For aeroplanes equipped with limiters that automatically prevent engine operating limits from being exceeded, other means may be used to increase the maximum level of power controlled by the power levers in the event of an APR failure. The means must be located on or forward of the power levers, must be easily identified and operated under all operating conditions by a single action of any pilot with the hand that is normally used to actuate the power levers, and must meet the requirements of chapter 523.777(a), (b), and (c).

(Change 523-4 (96-09-01))

H523.6 *Powerplant Instruments*

In addition to the requirements of 523.1305:

(a) A means must be provided to indicate when the APR is in the armed or ready condition.

(b) If the inherent flight characteristics of the aeroplane do not provide warning that an engine has failed, a warning system independent of the APR must be provided to give the pilot a clear warning of any engine failure during takeoff.

(c) Following an engine failure at V_1 or above, there must be means for the crew to readily and quickly verify that the APR has operated satisfactorily.

(Change 523-4 (96-09-01))

APPENDIX I
SEAPLANE LOADS

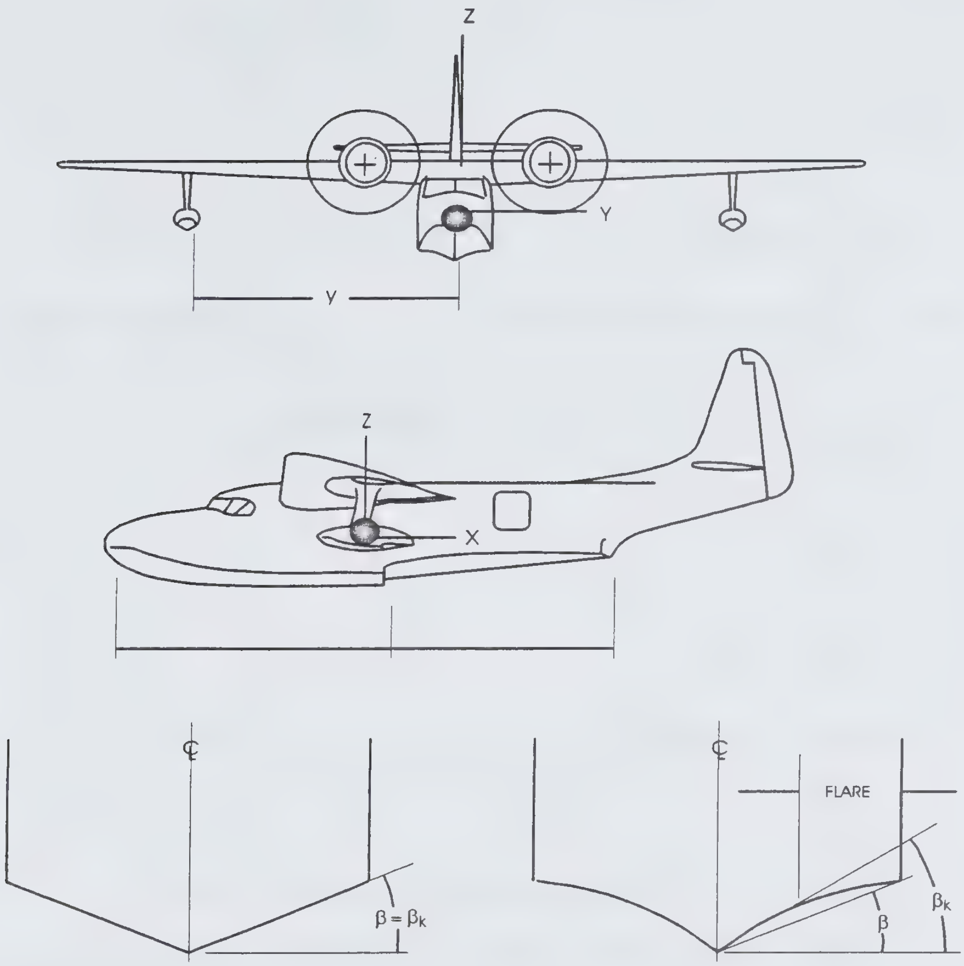
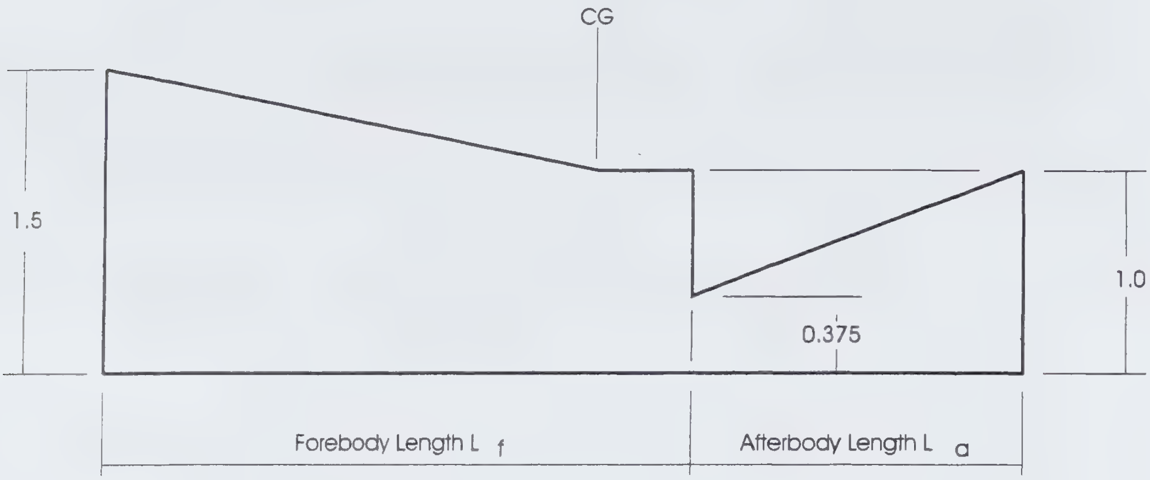
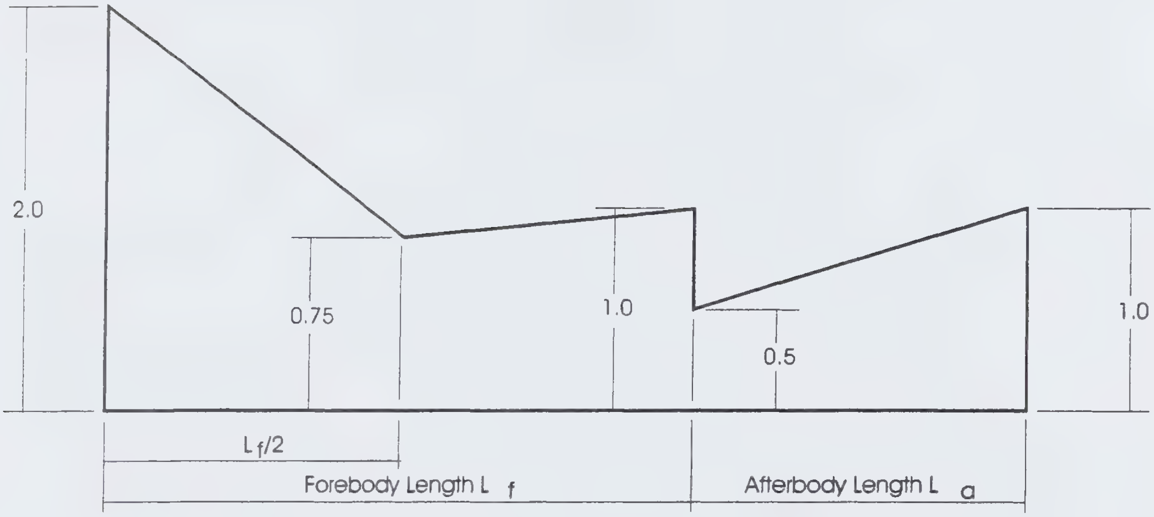


Figure I-i Pictorial definition of angles, dimensions and directions on a seaplane



K 1 (Vertical Loads)



K 2 (Bottom Pressures)

Figure I-ii - Hull station weighing factor

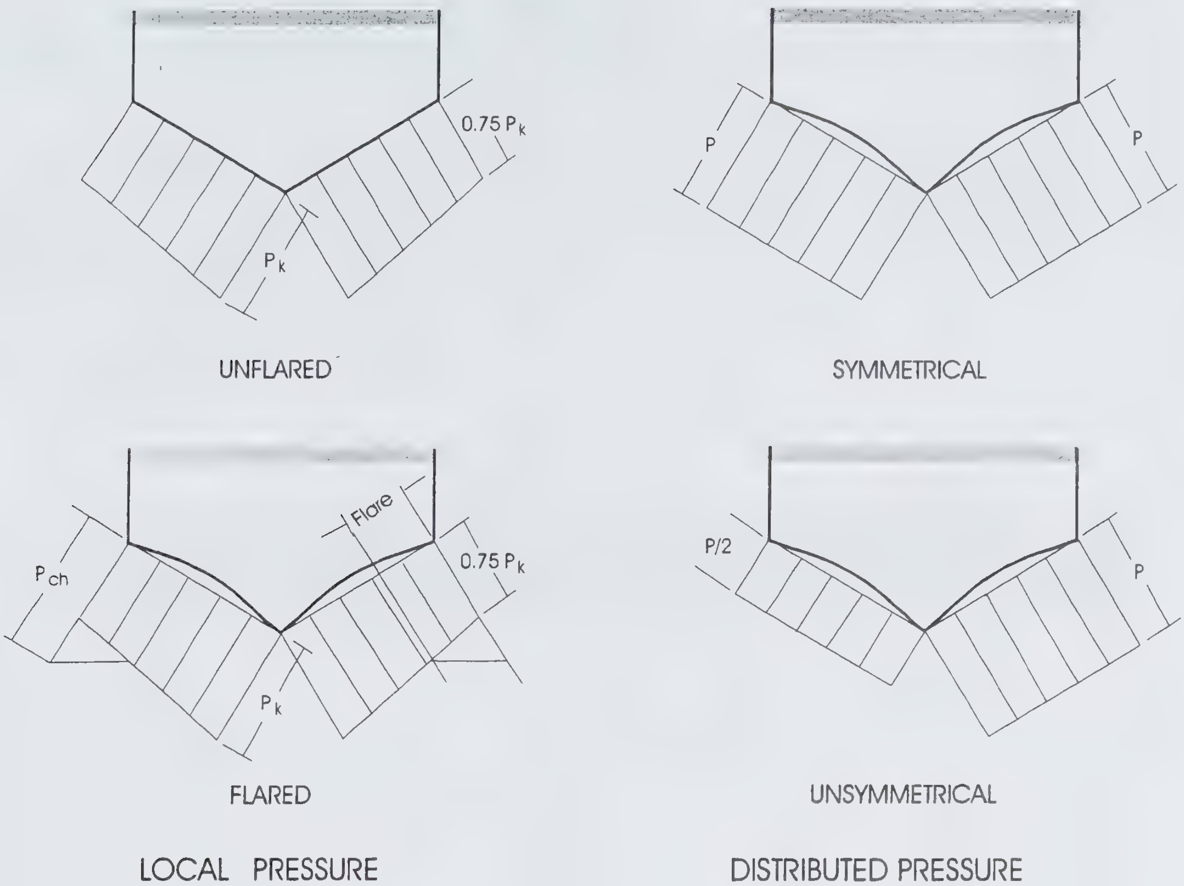


Figure I-iii Transverse pressure distributions

(Change 523-4 (96-09-01))

APPENDIX J
HIRF ENVIRONMENTS AND EQUIPMENT HIRF TEST LEVELS

(amended 2008/10/30)

This appendix specifies the HIRF environments and equipment HIRF test levels for electrical and electronic systems under 523.1308. The field strength values for the HIRF environments and equipment HIRF test levels are expressed in root-mean-square units measured during the peak of the modulation cycle.
(amended 2008/10/30)

(a) HIRF environment I is specified in the following table:
(amended 2008/10/30)

Table I - HIRF Environment I
(amended 2008/10/30)

FREQUENCY	FIELD STRENGTH (volts/meter)	
	PEAK	AVERAGE
10 kHz - 2 MHz	50	50
2 MHz – 30 MHz	100	100
30 MHz – 100 MHz	50	50
100 MHz – 400 MHz	100	100
400 MHz – 700 MHz	700	50
700 MHz – 1 GHz	700	100
1 GHz – 2 GHz	2 000	200
2 GHz – 6 GHz	3 000	200
6 GHz – 8 GHz	1 000	200
8 GHz – 12 GHz	3 000	300
12 GHz – 18 GHz	2 000	200
18 GHz – 40 GHz	600	200
In this table, the higher field strength applies at the frequency band edges		

(b) HIRF environment II is specified in the following table:
(amended 2008/10/30)

Table II - HIRF Environment II
(amended 2008/10/30)

FREQUENCY	FIELD STRENGTH (volts/meter)	
	PEAK	AVERAGE
10 kHz – 500 kHz	20	20
500 kHz – 2 MHz	30	30

FREQUENCY	FIELD STRENGTH (volts/meter)	
	PEAK	AVERAGE
2 MHz – 30 MHz	100	100
30 MHz – 100 MHz	10	10
100 MHz – 200 MHz	30	10
200 MHz – 400 MHz	10	10
400 MHz – 1 GHz	700	40
1 GHz – 2 GHz	1 300	160
2 GHz – 4 GHz	3 000	120
4 GHz – 6 GHz	3 000	160
6 GHz – 8 GHz	4 00	170
8 GHz – 12 GHz	1 230	230
12 GHz – 18 GHz	730	190
18 GHz – 40 GHz	600	150
In this table, the higher field strength applies at the frequency band edges		

(c) Equipment HIRF Test Level 1
(amended 2008/10/30)

(1) From 10 kilohertz (kHz) to 400 megahertz (MHz), use conducted susceptibility tests with continuous wave (CW) and 1 kHz square wave modulation with 90 percent depth or greater. The conducted susceptibility current shall start at a minimum of 0.6 milliamperes (mA) at 10 kHz, increasing 20 decibels (dB) per frequency decade to a minimum of 30 mA at 500 kHz.
(amended 2008/10/30)

(2) From 500 kHz to 40 MHz, the conducted susceptibility current shall be at least 30 mA.
(amended 2008/10/30)

(3) From 40 MHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 30 mA at 40 MHz, decreasing 20 dB per frequency decade to a minimum of 3 mA at 400 MHz.
(amended 2008/10/30)

(4) From 100 MHz to 400 MHz, use radiated susceptibility tests at a minimum of 20 volts per meter (V/m) peak with CW and 1 kHz square wave modulation with 90 percent depth or greater.
(amended 2008/10/30)

(5) From 400 MHz to 8 gigahertz (GHz), use radiated susceptibility tests at a minimum of 150 V/m peak with pulse modulation of 4 percent duty cycle with a 1 kHz pulse repetition frequency. This signal shall be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent.
(amended 2008/10/30)

(d) Equipment HIRF Test Level 2
(amended 2008/10/30)

Equipment HIRF test level 2 is HIRF environment II in table II of this appendix reduced by acceptable aircraft transfer function and attenuation curves. Testing shall cover the frequency band of 10 kHz to 8 GHz.

(e) Equipment HIRF Test Level 3
(amended 2008/10/30)

(1) From 10 kHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 0.15 mA at 10 kHz, increasing 20 dB per frequency decade to a minimum of 7.5 mA at 500 kHz.
(amended 2008/10/30)

(2) From 500 kHz to 40 MHz, use conducted susceptibility tests at a minimum of 7.5 mA.
(amended 2008/10/30)

(3) From 40 MHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 7.5 mA at 40 MHz, decreasing 20 dB per frequency decade to a minimum of 0.75 mA at 400 MHz.
(amended 2008/10/30)

(4) From 100 MHz to 8 GHz, use radiated susceptibility tests at a minimum of 5 V/m.
(amended 2008/10/30)

AIRWORTHINESS MANUAL
CHAPTER 523-VLA

Table of Contents

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The publication of revised advisory material:

- AMA 523VLA/1A Advisory Circulars - Joint (ACJ's) Very Light Aeroplanes, dated 15 November 1999.

The cancellation of the following advisory material:

- AMA 523VLA/2 Additional Technical Requirements For Night And IFR Approval, dated 30 June 1993.

Note: *All changes will be identified by brackets [ ]; editorial changes and typographical corrections will not be identified.*

Change 523-VLA-2 **Effective December 1, 2004**

In an effort to harmonize our regulatory guidance documents with those of other international aviation authorities and other branches within Transport Canada Civil Aviation (TCCA), the Aircraft Certification Branch has decided to replace existing Airworthiness Manual Advisories (AMA) related to certification of aeronautical products with new Advisory Circulars (AC). While the content of the new ACs will remain technically the same as the corresponding AMAs, which they will replace, the format of the ACs will be standardized to conform to other guidance documents published within the branch.

This change in guidance documentation becomes effective 1 December 2004 at which time the AMAs will be cancelled and replaced by their corresponding Advisory Circular concurrent with the next publishing of the Canadian Aviation Regulations (CAR). After this time, the CARAC Secretariat will no longer publish these AMAs and, consequently, ACs will not be published with their corresponding AWM Chapter. As of the 1 December 2004 issue of the CARs, any affected AMA references and content will have been removed. However, the AMA Index found in AMA 500/00 will, for now, continue to exist to provide a cross-reference between the old AMAs and the new ACs.

Change 523-VLA-3 **Published: December 1, 2009**

On December 1, 2009, Part V Subpart 21 of the *Canadian Aviation Regulations* (CAR 521) came into force. CAR 521 replaces the following Regulations in Part V—Airworthiness:

Subpart 11 - Approval of the Type Design of an Aeronautical Product

Subpart 13 - Approval of Modification and Repair Designs

Subpart 16 - Aircraft Emissions

Subpart 22 - Gliders and Powered Gliders

Subpart 23 - Normal, Utility, Aerobatic and Commuter Category Aeroplanes

Subpart 25 - Transport Category Aeroplanes

Subpart 27 - Normal Category Rotorcraft

Subpart 29 - Transport Category Rotorcraft

Subpart 31 - Manned Free Balloons

Subpart 33 - Aircraft Engines

Subpart 35 - Aircraft Propellers

Subpart 37 - Aircraft Appliances and Other Aeronautical Products

Subpart 41 - Airships

Subpart 51 - Aircraft Equipment

Subpart 91 - Service Difficulty Reporting

Subpart 93 - Airworthiness Directives

In addition, with publication of CAR 521, the following Chapters of the Airworthiness Manual have been withdrawn:

Chapter 511 - Approval of the Type Design of an Aeronautical Product

Chapter 513 - Approval of Modification and Repair Designs

Standard 591 - Service Difficulty Reporting

Standard 593 - Airworthiness Directives

This change amends section 523-VLA.1 to reflect changes in legal drafting style, in terminology and in references required because of the introduction of CAR 521. In addition, subsection 521.31(1) of the CARs is now used to legally enable this Chapter of the AWM.

PART V – AIRWORTHINESS

AIRWORTHINESS MANUAL CHAPTER 523-VLA

(2001/12/01)

SUBCHAPTER A
GENERAL

523-VLA.1 *Applicability*

(a) This subchapter sets out airworthiness standards for the issue of type certificates and changes to those type certificates for very light aeroplanes (VLA) of conventional design and construction in the normal and utility categories.

(b) A VLA is an aeroplane with a single engine (spark or compression ignition), having not more than two seats, with a Maximum Certificated Takeoff Weight of not more than 750 kg (1653.5 lbs.) and a stalling speed in the landing configuration of not more than 45 knots Calibrated Air Speed (CAS).
(amended 2009/12/01)

JAR: This JAR-VLA prescribes airworthiness standards for issuance of a type certificate, and changes to that type certificate, for an aeroplane with a single engine (spark- or compression-ignition) having not more than two seats, with a Maximum Certificated Takeoff Weight of not more than 750 kg and a stalling speed in the landing configuration of not more than 45 knots (CAS). The approval to be for day-VFR only.

(c) Reserved.
(amended 2009/12/01)

JAR: Each person who applies for such a certificate or change must show compliance with the applicable requirements stated herein.
(amended 2004/12/01)

523-VLA.3 *[Aeroplane Categories]*

[*(a)* Normal category aeroplanes are intended for non-aerobatic operations. Non- aerobatic operations include:

(1) any manoeuvres incident to normal flying;

(2) stalls (except whip stalls); and

(3) lazy eights, chandelles and steep turns in which the angle of bank is not more than 60°.

JAR: This JAR-VLA applies to aeroplanes intended for non-aerobatic operation only. Non-aerobatic operation includes:

(a) any manoeuvre incident to normal flying;

(b) stalls (except whip stalls); and

(c) lazy eights, chandelles, and steep turns, in which the angle of bank is not more than 60°.

(b) Utility category aeroplanes are intended for limited aerobatic operations. Limited aerobatic operations include:

(1) spins (if approved for the particular type of aeroplane); and

(2) lazy eights, chandelles and steep turns in which the angle of bank is more than 60°.

JAR - No corresponding text.

(Change 523-VLA-1)

523-VLA.5 *Variations to JAR-VLA*

The airworthiness standards for the design of very light aeroplanes are set out in:

(a) JAR-VLA, dated 26 April, 1990, as amended by orange paper amendment VLA/91/1 and VLA/92/1; and

(b) The variations are identified in this Chapter. Unless otherwise indicated, each section in this chapter replaces the equivalent paragraph in JAR-VLA, and where no equivalent JAR-VLA paragraph exists the stated requirement is in addition to the JAR-VLA requirements.

JAR - No corresponding text.

(Change 523-VLA-1)

SUBCHAPTER B
FLIGHT

523-VLA.65 Climb: All Engines Operating

Aeroplanes limited to VFR day operation shall meet the requirements of JAR-VLA 65, aeroplanes intended for VFR night or IFR operation shall have a steady climb gradient at sea level of at least 8.3 percent for landplanes or 6.7 percent for seaplanes and amphibians with:

(a) not more than maximum continuous power on each engine;

(b) the landing gear retracted;

(c) the wing flaps in the takeoff position(s);

(d) a climb speed not less than 1.2 V_{S1}; and

(e) the cowl flaps or other means for controlling the engine cooling air supply in the position used in the cooling tests required by JAR-VLA 1041 through JAR-VLA 1047.

(Change 523-VLA-1)

523-VLA.221 Spinning

(a) A normal category aeroplane shall meet the requirements of JAR-VLA 221.

(b) A utility category aeroplane shall meet the requirements of JAR-VLA 221. In addition, the requirements of paragraph (c) of this section shall be met if approval for spinning is requested.

Transport Canada Transports Canada

TP 6197 E

CARs

CANADIAN AVIATION REGULATIONS

PART V - AIRWORTHINESS

AIRWORTHINESS MANUAL CHAPTER 525 – TRANSPORT CATEGORY AEROPLANES

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NOTE

All amendments to the CARs will be indicated by the Coming into Force date, immediately following the amended text.

RECORD OF AMENDMENTS

Date of Amendment	*Date Entered*	*Entered by*
30 Jun 2009	2012/03/30	[illegible]
2009/12/01	" "	[illegible]
2010/06/01	" "	[illegible]
2010/06/16	" "	[illegible]
2010/05/27	" "	[illegible]
2012/03/27	" "	[illegible]

Date of Amendment	*Date Entered*	*Entered by*

AIRWORTHINESS MANUAL CHAPTER 525 — TRANSPORT CATEGORY AEROPLANES

Table of Contents

Preamble

General

The content of this chapter is based on the *United States Code of Federal Regulations, Title 14, Chapter I, Part 25* entitled, *Airworthiness Standards, Transport Category Airplanes*. These United States airworthiness standards have been used and adopted as the model for the Canadian standards supplemented by additional airworthiness requirements based on Canadian experience and required for Canadian aviation purposes.

The FAR numbering system is used. The Canadian standards bears the same number as the FAR equivalent, prefixed by the number "5", as this chapter contains the standards for *Part V* of the *Canadian Aviation Regulations* (*CAR*s).

First Edition **Effective: July 1, 1986**

The standards in this chapter are presented in a two column format with the United States FAR in the left column and the Canadian standards in the right column. Chapters, sub-chapters, sections and subsections numbering and headings are opposite to the equivalent FAR. Where the Canadian standard is identical to the FAR, the words "No Variation" appear; where a variation exists, the affected part of text is printed opposite to the FAR with all changes underlined.

The first issue of this chapter is based on FAR Part 25, up to and including amendment 25-59. In addition to administrative changes (e.g., Administrator = Minister; Part = Chapter) and the deletion of references to operating FARs, the Canadian variations included in this edition are as follows:

Stall Demonstration: characteristics generated by automatic systems, section 525.201, paragraph (d)(1).

Stall Warning: section 525.207, paragraph (b)

Lift and Drag Devices: in-flight controls operation, section 525.697, paragraph (b).

Life and Drag Devices, Indicator: section 525.699 paragraph (d).

Emergency Evacuation: the requirements of section 525.803, para (b) have been relocated to section 525.807 paragraph (c)(6)(ii) and (c)(6)(iii) for clarity.

Passenger Emergency Exits: exits in excess of the minimum required number, section 525.807, paragraph (c)(6).

Aeroplane Operations after Ground Cold Soak: section 525.1301-1.

Miscellaneous Marking and Placards: use of metric units, section 525.1557, paragraph (b)(3).

Aeroplane Flight Manual: section 525.1581: use of metric units para (e), and reference to operating rules, paragraph (f).

In addition, the following Airworthiness Manual Advisories (AMA) are attached to this chapter.

AMA 500C/1 Aircraft Equipment Incorporating Digital Computer Technology, dated 1 May 1986.

AMA 500C/2 Multipurpose Electronic Flight Deck Display Systems, dated 1 May 1986.

AMA 500C/3 Fire Protection - Ignition Sources, dated 1 May 1986.

AMA 500C/4 Portable Fire Extinguishers For Use In Aircraft, dated 1 May 1986.

AMA 500C/5A Aircraft Operations After Ground Cold Soak, dated 1 May 1986.

AMA 525/1 Stalls, Compliance, dated 1 May 1986.

AMA 525.671 Aeroplane Flight Control System Failure Analysis, dated 1 May 1986.

AMA 525.697 Lift and Drag Devices, Controls and Indicators, dated 1 May 1986.

AMA 525.933 Thrust Reversing Systems, Turbo-Jet Engines, dated 1 May 1986.

AMA 525.1091 Engine Ingestion of Water/Slush Due to Runway Conditions, dated 1 May 1986.

AMA 525.1191 Firewalls - Criteria for Fireproofing , dated 1 May 1986.

AMA 525.1309 Aeroplane Equipment, Systems, and Installation Probability Analysis, dated 1 May 1986.

Change 525-1 **Effective: January 1, 1987**

This change incorporates the following amendments to the United States Code of Federal Regulations, Title 14, Chapter 1, Part 25, effective in Canada on the dates specified herein:

Amendments 25-60 and 25-61 to the *United States Code of Federal Regulations*, Title 14, Chapter I, Part 25 published in the *Federal Register* dated 16 May 1986 and 21 July 1986 respectively; and

A new Canadian airworthiness standards which allows conditional use of rated take-off power or thrust up to 10 minutes in case of OEI climb; Section 525.1521, paragraph (b)(6).

In addition, the publication of the following new or revised advisory material:

AMA 500C/4A Portable Fire Extinguishers for Use in Aircraft, dated 25 March 1987.

AMA 525.1521 Conditional Use of Rated Take-Off Power/Thrust Up to 10 Minutes For one-Engine- Inoperative Climb Operation, dated 1 January 1987.

AMA 525.1581 *Aeroplane Flight Manual*, dated 1 January 1987.

Information Note: *In 525-1 changes were identified by marginal black lines. In future, changes will be identified by brackets ; editorial alterations and typographical corrections will not be identified.*

Change 525-2 **Effective: January 1, 1989**

This Change incorporates the following amendments to the *United States Code of Federal Regulations*, Title 14, Chapter I, Part 25:

Amendment 25-62 "*Standards for Approval of an Automatic Take-off Thrust Control System (ATTCS)*", which provides newly developed standards (previously special conditions) for the installation of an ATTCS. The amendment specifies maximum thrust limits, prescribes system reliability and system status monitoring and promulgates details of

manual selection of maximum approved take-off thrust. The amendment is based on special conditions developed for the Boeing 727 and Douglas DC-9 ATTCS designs.

Amendment 25-63 "*Standards Governing the Noise Certification of Aircraft*", which revises certain noise certification requirements which makes the associated regulations more manageable. Hence the noise test procedures are simplified, the equipment specifications are updated to better accommodate the use of current digital technology and the number of flight tests required to approve relatively minor aircraft modifications is reduced.

Amendment 25-64 "*Improved Seat Safety Standards*", which upgrades the standards for occupant protection during emergency landing conditions (i.e. static load factors in the upward, downward and sideward direction with an aft direction requirement added). Seat restraint requirements were revised and impact injury criteria were defined based on research testing and service experience.

Amendment 25-65 "*Cockpit Voice Recorders and Flight Data Recorders*", which amends flight data recorder and cockpit voice recorder regulations to provide more information to accident investigators. Generally, the requirements and parameters for flight recorders are upgraded to the level of the most sophisticated systems available; the use of digital recording equipment will henceforth become the norm. Additionally, uninterrupted sound recording will be required in cockpit voice recorders.

Amendment 25-66 "*Improved Flammability Standards for Materials Used in the Interiors of Transport Category Airplane Cabins*", which upgrades the fire safety standards for cabin interior materials by establishing refined fire test procedures (and apparatus) and a new requirement for smoke emission testing. The research conducted also determined that the reproducibility of test results would improve. Smoke emission testing is to reduce the possibility that emergency egress will be hampered by smoke obscuration.

This change also includes:

A correction to paragraph 525.145(a) to delete the reference to 525.49(c)(2)(i). this to correct an error published in the Federal Register, amendment 25-38 dated February 1, 1977, where the FAA deleted FAR section 25.49 without amending the cross reference contained in section 25.145 paragraph (a).

A Canadian rule change addressing the determination of take-off and landing performances for operation from unpaved runways. Sections 525.105 and 525.125 are amended by adding new paragraphs (c)(1) and (b) respectively.

Advisory material (AMA 525/4) providing guidance in demonstrating compliance with the requirements of the new paragraphs 525.105(c)(1) and 525.125(b).

The reissue of advisory material on the operation of thrust reversing systems following landing touch-down and selection of reverse thrust for turbine engine propeller aeroplanes. The new AMA 525/3 supersedes the original advisory (AMA 525.933) which addressed only turbojet thrust reversing systems.

The publication of the following new or revised advisory material:

AMA 500C/5A Aircraft Operations After Ground Cold Soak, dated 25 March 1987.

AMA 525/3 Operation of Thrust Reversing Systems, dated 24 August 1988.

AMA 525/4 Operations From Unpaved Runways, dated 1 February 1988.

The rewriting of the original Introduction and Foreword in the form of Preamble.

Change 525-3 **Effective: November 1, 1991**

This Change incorporates the following amendments to the *United States Code of Federal Regulations*, Title 14, Chapter I, Part 25:

Amendment 25-67 "*Location of Passenger Emergency Exits in Transport Category Airplanes*" which establishes a new standards that limits the distance between emergency exits on transport category aeroplanes to improve safe passenger evacuation during emergency.

Amendment 25-68. This amendment changes a cross reference to Part 91 in Appendix A of Part 25 and as such it is not applicable in Canada. This FAR change is part of a larger reorganisation of the general U.S. operating and flight rules to make them more understandable and easier to use.

Amendment 25-69 "*Design Standards for Fuel Tank Access Covers*" which requires that fuel tank access covers be designed to minimize penetration by likely foreign objects and be fire resistant.

Amendment 25-70 "*Independent Power Source for Public Address System in Transport Category Airplanes*" which intends to ensure the availability of the public address (PA) system during emergency conditions by requiring an independent PA system power source. This amendment applies only to aeroplanes that are required by operating rules to have a PA system.

Amendment 25-71 "*Improved Structural Requirements for Pressurized Cabins and Compartments in Transport Category Airplanes*" which upgrades the airworthiness standards for pressurised compartments. It requires evaluation of openings in any pressurised compartment and examination of the effects of differential pressure loads on any critical structure inside or outside the pressurised compartment.

Amendment 25-72 "*Special Review: Transport Category Airplane Airworthiness Standards*" is a comprehensive update of the standards for clarity and accuracy, and ensures that the standards are appropriate and practicable for smaller transport category aeroplanes.

Amendment 25-73 "*Fuel Venting and Exhaust Emission Requirements for Turbine Engine Powered Airplanes*" which requires compliance with the new Part 34. Part 34 consolidates all of the applicable aircraft engine fuel venting and exhaust emission requirements of SFAR 27-5, and the test procedures specified under the U.S. regulations implementing the Clear Air Act of the United States of America. In lieu of Part 34, Transport Canada has adopted the standards of Annex 16 to the Convention on International Civil Aviation, Volume II entitled "Aircraft Engine Emission," First Edition 1981, published by ICAO. Accordingly, sections 525.903 and 525.951 are amended to refer to Chapter 516, Second Edition, Subchapter B.

Amendment 25-74 "*Airplane Cabin Fire Protection*" which provides improved cabin fire protection for transport category aeroplanes by requiring smoke detector systems and automatic fire extinguishers in each lavatory of certain aircraft; an increased number of hand fire extinguishers in the passenger compartment and galleys; and a specified number of extinguishers containing Halon 1211.

This change also includes:

The revision of the previous Preambles for clarity and completeness;

The rewriting of section 525.1 to refer to the *Air Regulation* enabling the type approval of aeronautical products; and

Changes to four Canadian Variations effected by FAA amendment 25-72, as follows:

(1) The requirements for ventral, tail-cone and floor level emergency exits of paragraph 525.803(b) and 525.807(c)(6) were incorporated if the FAA text. Therefore, the Canadian text is deleted and the new text of Part 25 is adopted. The cross reference between the old and the new text is old 525.803(b) = new 525.803(b)(reserved); old 525.807(c)(6) = new 525.807(d)(6)(i)

(2) Paragraph 525.1521(b)(6) containing the requirement for the use of rated take-off power or thrust up to 10 minute, is renumbered as paragraph 525.1521(e) and a new introductory sentence is added.

(3) Paragraph 525.1557(b)(3) containing the requirement for placards and markings at powerplant fuel openings is renumbered as 525.1557(b)(4).

The publication of the following new or revised advisory material:

AMA 500C/5B, "Aircraft Operation after Ground Cold Soak" dated March 2, 1990;

AMA 500C/6, "Lightning Protection of Aircraft Fuel System" dated Oct. 27, 1989.

AMA 500C/8, "Composite Aircraft Structures" dated Jan. 8, 1991.

and the cancellation of AMA 525.1309, which is replaced by FAA AC 25.1309-1A.

Change 525-4 **Effective: August 1, 1992**

This Change incorporates amendment 25-75 to the *United States Code of Federal Regulations*, Title 14, Chapter I, Part 25, entitled "*Landing Gear Aural Warning*". This amendment requires that in Transport Category aeroplanes, when the landing gear is not locked down, the flight crew must be given an aural warning. This amendment intends to eliminate nuisance warnings and to simplify the certification process.

This Change also includes:

- An amendment to section 525.1581 by adding a new paragraph (g). This amendment requires that the *Aeroplane Flight Manual* contain approved guidance material for procedures and performance information when operating from wet and contaminated runways; and
- Editorial corrections.

Change 525-5 **Effective: October 30, 1992**

This change incorporates the following amendments to the *United States Code of Federal Regulations*, Title 14, Chapter I, Part 25:

Amendment 25-76 "*Improved Access To Type III Exits*" which establishes improved ability of occupants to evacuate an aircraft under emergency conditions.

Amendment 25-77 "*Vibration Buffet And Aeroelastic Stability Requirements For Transport Category Airplanes*", which clarifies the requirement to consider flutter and divergence when treating certain damage and failure conditions required by other sections of the FAR and adjusts the safety margins related to aeroelastic stability to make them more appropriate for the conditions to which they apply.

Change 525-6 **Effective: December 30, 1993**

This change incorporates the following amendments to the *United States Code of Federal Regulations*, Title 14, Chapter I, Part 25:

Amendment 25-78 "*Use of Nitrogen or Other Inert Gas for Tire Inflation in Lieu of Air*" to eliminate the possibility of tire explosion.

Amendment 25-79 "*Emergency Evacuation Demonstration Procedures, Exit Handle Illumination Requirements and Public Address Systems*".

The English version of this change also includes a correction to Appendix F, Part I, paragraph (a)(1)(ii) to take care of an oversight during the incorporation of FAA amendment 25-70 published as change 525-3.

This change also includes:

The publication of advisory material AMA 525/10, Performance of Turbo Propeller Powered Large Aeroplanes used for Special Purpose Operations (Restricted Category), dated November 23, 1993

Editorial corrections

Change 525-7 **Effective: September 30, 1996**

This change introduces a new format such as the removal of the left-hand column containing the FARs. The Canadian standards in this chapter are now presented in a newspaper column format with variations from the FARs underlined. The change number and date of affected *pages* has been removed from the bottom of the page. Instead, affected *sections* will be followed by change numbers and dates of current changes as well as any previous changes.

This change incorporates the following amendments to the United States Code of Federal Regulations, Title 14, Chapter I, Part 25:

Amendment 25-80 "*Electrical and Electronic Systems Lightning Protection*" providing specific lightning protection requirements for electrical and electronic systems that perform essential or critical functions. The adoption of this FAR Amendment was object of NPA 94-08 dated 28 June 1994.

Amendment 25-81 "*Design Standards for Airplane Jacking and Tie-Down Provision*" intended to protect primary aeroplane structure during jacking operations and from gusty

wind conditions while tied down. The adoption of this FAR Amendment was object of NPA 94-09 dated 28 June 1994.

Amendment 25-82 "*Emergency Locator Transmitters*" requires that newly installed emergency locator transmitters be of an improved design that meets the requirements of a revised TSO or later TSOs issued for ELTs. The adoption of this FAR Amendment was object of NPA 94-15 dated 25 October 1994.

Amendment 25-83 "*Improved Flammability Standards for Material Used in the Interiors of Transport Category Aeroplane Cabins*" intended to clarify standards adopted by FAA in 1986 concerning the flammability of components used in the cabins of certain transport category aeroplanes. The adoption of this FAR Amendment was object of NPA 95-05 dated 17 October 1996.

Amendment 25-84 "*Revision of Certain Flight Airworthiness Standards to Harmonize with European Airworthiness Standards for Transport Category Aircraft*" proposes to amend Chapter 525 to harmonize certain flight requirements with the European Joint Aviation Requirements 25. The adoption of this FAR Amendment was object of NPA 95-08 dated 17 October 1996.

Amendment 25-85

Information Note: *Amendment 25-85, "Revision of Authority Citation" was not adopted as it dealt with the recodification of the US Federal Aviation Act of 1958 and is therefore not applicable.*

This change also includes:

The publication of the following new or revised advisory material:

AMA 500C/8A. Composite Aircraft Structure, dated 1 September 1996

AMA 500/9 Standards For The Design And Installation of Aircraft Skis, dated 1 September 1996

AMA 525/2 Flight In Icing Conditions - Performance, dated 1 September 1996

AMA 525/5 Flight In Icing Conditions - Flight Characteristics, dated 1 September 1996

AMA 525/7 Controllability During Approach And Landing V_{MCL}, Considerations, dated 1 September 1996

AMA 525/8 Performance Credit For Use of Power And Propeller Blade Pitch During Accelerate Stop and Landing Ground Roll, dated 1 September 1996

AMA 525/11 Flight Characteristics with Lateral Centre of Gravity, dated 1 September 1996

AMA 525.1581/2 Computerised *Aeroplane Flight Manual* Performance Systems, dated 1 September 1996

The cancellation of AMA 500C/1, that is superseded by FAA AC 20-115B.

The cancellation of Canadian variation 525.201(d) (1) due to the incorporation of FAR Amendment 25-84. (NPA 85-08)

1. General

This change introduces a new format such as the removal of the left-hand column containing the FARs. The Canadian standards in this chapter are now presented in a full-page format. Canadian variations from the FARs are underlined with the FAR text following in a shaded box. The change number and date of affected pages has been removed from the bottom of the page. Instead, affected *sections* will be followed by change numbers and dates of current changes as well as any previous changes.

With the incorporation of this change, the entire chapter, including all the associated advisory material (AMAs), is republished in a Second Edition. The chapter is presented in a new format common to the versions made available on the Internet and CD Rom.

2. FAR Amendments

This change incorporates the technical standards contained in the following amendments to the United States Code of Federal Regulations, Title 14, Chapter 1, Part 25, for which Notices of Proposed Amendments (NPAs) were issued to solicit industry comments on their adoption by reference.

These NPAs were issued under the simplified procedure for the amendment of the design standards of the Airworthiness Manual, approved by the Civil Aviation Regulatory Committee on October 15, 1997, and are noted in the following FAR amendment description.

FAR Amendment 25-86 **Effective: June 30, 1997**

This Amendment entitled "*Revised Discrete Gust Load Design Requirements*" replaces the current discrete gust requirement with a new requirement for a discrete tuned gust; modifies the method of establishing the design airspeed for maximum gust intensity; and provides for an operational rough airspeed. These changes also provide for harmonization with the Joint Aviation Requirements (JAR) of Europe. (NPA 97-167).

FAR Amendment 25-87 **Effective: June 30, 1997**

This Amendment entitled "*Standards for Approval for High Altitude Operation of Subsonic Transport Airplanes*" specifies aeroplane and equipment airworthiness standards for subsonic transport aeroplanes to be operated up to an altitude of 51,000 feet. (NPA 97-167).

Information Note: *FAA Advisory Circular 25-20, "Pressurization, Ventilation and Oxygen Systems Assessment for Subsonic Flight including High Altitude Operation" has been accepted as guidance material on methods of compliance with the requirements introduced by Amendment 25-87.*

FAR Amendment 25-88 **Effective: June 30, 1997**

This Amendment entitled "*Type and Number of Passenger Emergency Exits Required in Transport Category Airplanes*" defines two new types of passenger emergency exits in transport category aeroplanes, provides more consistent standards with respect to the passenger seating allowed for each exit type and combination of exit types, and requires escape slides to be erected in less time. These changes allow more flexibililty in the design of emergency exits and reflect recent improvements in escape slide technology. It will also

enable more cost-effective emergency exit arrangements and, in the case of escape slides, enable more rapid egress of passengers under emergency conditions. (NPA 97-167).

FAR Amendment 25-89 **Effective: June 30, 1997**

This Amendment entitled "*Allowable Carbon Dioxide Concentration in Transport Category Airplane Cabins*" revises the standards for maximum allowable carbon dioxide (CO_2) concentration in occupied areas of transport category aeroplanes by reducing the maximum allowable concentration from 3 percent to 0.5 percent. (NPA 97-167).

FAR Amendment 25-90

Information Note:

Amendment 25-90 "Operating Requirements: Domestic...etc." revises the FAR 121 operating rule cited in FAR 25.1303(b)(4). The equivalent provision in Chapter 525 currently makes general, rather than specific, reference to the applicable Canadian operating rules. This amendment does not require a change in Chapter 525.

FAR Amendment 25-91 **Effective: February 8, 1998**

This Amendment entitled "*Revised Structural Loads Requirements for Transport Category Airplanes*" introduces changes intended to achieve a common airworthiness standards and language between the requirements of the Federal Aviation Regulations and the Joint Aviation Requirements of Europe while maintaining at least the level of safety provided by the current regulations and industry practices. (NPA 97-450).

FAR Amendment 25-92 **Effective: June 1, 1998**

This Amendment entitled "*Improved Standards for Determining Rejected Takeoff and Landing*". This amendment amends the airworthiness standards for transport category aeroplanes to revise the methods for taking into account the time needed for the pilot to accomplish the procedures for a rejected take-off; require that take-off performance be determined for wet runways; and require that rejected take-off and landing stopping distances be based on worn brakes. (NPA 98-125).

Due to the incorporation of this amendment the Canadian variation 525.1581(g) is amended by deleting reference to wet runways. (NPA 2000-98).

FAR Amendment 25-93 **Effective: June 1, 1998**

This Amendment entitled "*Revised Standards for Cargo or Baggage Compartments in Transport Category Airplanes*" upgrades the fire safety standards for cargo or baggage compartments in certain transport category aeroplanes by eliminating Class D compartments as an option for future type certification. Compartments that can no longer be designated as Class D must meet the standards for Class C or Class E compartments, as applicable. (NPA 98-126).

Information Note: *FAA Amendment 25-93 was issued together with Amendment 121-269, which addressed the retrofitting of the existing fleet. Equivalent requirements for retrofitting the Canadian fleet have been addressed by NPA 98-163 and 98-164 for publication in CAR Part VII.*

FAR Amendment 25-94 **Effective: June 1, 1998**

This Amendment corrects a number of errors in the safety standards for transport category aeroplanes. None of the changes are substantive in nature, and none will impose any additional burden on any person. (NPA 98-127).

FAR Amendment 25-95 **Effective: October 29, 1998**

This Amendment entitled "*Airworthiness Standards; Rain and Hail Ingestion Standards*" establishes revisions to the Federal Aviation Administration's certification standards for rain and hail ingestion for aircraft turbine engines. This amendment addresses engine power-loss and instability phenomena attributed to operation in extreme rain or hail that are not adequately addressed by current requirements. This amendment also generally harmonizes these standards with rain and hail ingestion standards being amended by the Joint Aviation Authorities (JAA). These amendments establish nearly uniform standards for engines certified in the United States under 14 CFR part 33 and in the JAA countries under Joint Airworthiness Requirements-Engines (JAR-E), thereby simplifying the certification of engine designs by the FAA and the JAA. (NPA 98-159).

FAR Amendment 25-96 **Effective: October 29, 1998**

This Amendment entitled "*Fatigue Evluation of Structure*" amends the fatigue requirements for damage-tolerant structure on transport category aeroplanes to require a demonstration using sufficient full-scale fatigue test evidence that widespread multiple-site damage will not occur within the design service goal of the aeroplane; and inspection thresholds for certain types of structure based on crack growth from likely initial defects. This change is needed to ensure the continued airworthiness of structures designed to the current damage tolerance requirements, and to ensure that should serious fatigue damage occur within the design service goal of the aeroplane, the remaining structure can withstand loads that are likely to occur, without failure, until the damage is detected and repaired. (NPA 98-160).

FAR Amendment 25-97 **Effective: October 29, 1998**

This amendment entitled "*Braked Roll Conditions*" adds a new design standard that requires that the aeroplane be designed to withstand main landing gear maximum braking forces during ground operations. This amendment will ensure that the landing gear and fuselage are capable of withstanding the dynamic loads associated with the maximum dynamic braking condition. It also relieves a burden on industry by eliminating differences between the Federal Aviation Regulations (FAR) and European Joint Aviation Requirements (JAR), while maintaining a level of safety provided by the current regulations and industry practices. (NPA 98-176).

FAR Amendment 25-98 **Effective: November 23, 1999**

This action amends the airworthiness standards for transport category aeroplanes to revise the requirements concerning gated positions on the control used by the pilot to select the position of an aeroplane's high-lift devices. This amendment updates the current standards to take into account the multiple configurations of the high-lift devices provided on current aeroplanes to perform landings and go-around maneuvers. This final rule also harmonizes these standards with those being adopted by the European Joint Aviation Authorities (JAA). (NPA 99-170).

3. CARAC Working Group

This amendment also implements the recommendations of CARAC Working Group 523-525

In 1996 the integration of the existing Design Standards of this Manual into the new Canadian Aviation Regulations (CARs), Part V was delayed as a result of a request by Canadian aviation industry to review these standards, in particular the Canadian variations, and all associated Canadian advisory material (AMAs) for their accuracy and appropriateness.

Due to the time-frame for CARs implementation, the CARAC Airworthiness Technical Committee V formed several Working Groups made up of industry and Transport Canada specialists to review those variations, AMAs and any applicable Special Conditions and make recommendations to the Committee for their disposition.

The final report of the 523/525 Working Group was completed in June 1997 and all its recommendations were accepted by the CARAC Technical Committee V. With the publication of this Change to Chapter 525, Transport Canada Civil Aviation, Aircraft Certification Branch, starts the implementation of those recommendations.

Therefore, this change includes:

(a) The amendment to Canadian variation 525.1581(g) as explained at FAR Amendment 25-92. (NPA 2000-98).

(b) The cancellation of the following Canadian variations effective on the date of publication of this change:

525.105(c)(1), and 525.125(b). (NPA 2000-95).

525.1581(e)(2) and (e)(3), and 525.1581(f). (NPA 2000-97).

(c) The publication of new or revised advisory material:

525/1A Stalls, Compliance, dated 12 November 1999.

525/2A Flight in Icing Conditions-Performance, dated 29 October 1999.

525/4A Operations from Unpaved Runways , dated 2 September 1999.

525/5A Flight in Icing Conditions-Flight Characteristics, dated 20 October 1999.

525/6A Downwind Take-Off and Landing, dated 15 November 1999.

525/7A Controllability During Approach And Landing V_{MCL}, Considerations, dated 30 June 1999.

525/8A Performance Credit for Use of Propeller Blade Pitch During Accelerate Stop and Landing Roll, dated 15 November 1999.

525/10A Performance of Turbo-Prop Powered Large Aeroplanes Used for Special Purpose Operations (Restricted Category), dated 23 November 1993.

525/11A Flight Characteristics with Lateral Center of Gravity, dated 1 September 1996.

525/12 Certification of Transport Category Aeroplanes On Narrow Runways , dated 19 November 1999.

525.671A Aeroplane Flight Control System Failure Analysis, dated 14 July 2000.

525.1521A Conditional use of Rated Take-off Power/Thrust, dated 15 July 2000.

525.1581A *Aeroplane Flight Manual*, dated 12 November 1999.

525.1581/2A Computerised *Aeroplane Flight Manual* Persormance Systems, dated 15 November 1999.

500C/3 Fire Protection - Ignition Sources, dated 1 May 1986.

500C/5B Aircraft Operation After Ground Cold Soak, dated 2 March 1990.

500/8B Composite Aircraft Structure, dated 8 November 1999.

500/9A Standards For The Design And Installation of Aircraft Skis, dated 29 October 1999.

500/11 Airworthiness Standards For The Design Of Aircraft Floats, dated 2 February 1998.

500/12 Carriage of Bulk Liquids in Aircraft, dated 7 April 2000

(d) The cancellation of the following advisory material:

500C/2 Multipurpose Electronic Flight Deck Display System, dated 1 May 1986.

500C/4A Portable Fire Extinguishers For Use In Aircraft, dated 25 March 1987.

In sections 525.812(h) and 525.1411 (c) cross references to 525.809(f) and (h) have been corrected to 525.810. (NPA 2000-96).

In FAR amendment 25-72, that was incorporated in this chapter at change 525-3, the requirements of 25.809 (f) and (h) were relocated in the new section 25.810. Due to an administrative oversight, the FAA did not correct the cross references in 25.812(h) and 25.1411 (c). In this change, Transport Canada is rectifying this error for applicability in Canada. FAA was advised and they will issue a correction to FAR 25.

4. Miscellaneous Changes

This change also includes editorial corrections, including editorial corrections to the Preamble at Change 525-7 and the update of cross references to CARs (e.g. 523.1).

Due to the consolidation of all regulatory requirements previously found in the Air Regulations and Air Navigation Orders into the new Canadian Aviation Regulations, administrative changes are included in this amendment to update the regulatory references and terminology (e.g. *Type Certificate* instead of *Type Approval*.

Change 525-8.1 - Special Amendment **Published: April 10, 2002**

This Special Amendment 525-8.1 incorporates enhanced aircraft security design standards in support of amended regulations in CAR 705.80 required in the wake of the September 11, 2001 terrorist attacks and the issuance of SFAR 92-3 by the FAA.

FAR Amendment 25-106 **Effective: March 21, 2002**

This amendment entitled "*Security Considerations in the Design of the Flightdeck on Transport Category Airplanes*" was introduced using NPA 2002-017 and NPA 2002-018 adoption by reference without consultation pursuant to subsection 103.04(1) of the *Canadian Aviation Regulations.* These NPAs define new design standards with respect to emergency

means to enable a flight attendant to enter the flight deck in the event the flight crew becomes incapacitated (525.772) and, intrusion and penetration resistance to pilot compartment doors (525.795).

Change 525-8.2 - Special Amendment **Published/Effective: April 9, 2003**

This Special Amendment is introduced by NPA 2003-123 pursuant to subsection 103.04(1) of the *Canadian Aviation Regulations* (CARs). This NPA adds the reference to subsection 701.30(1) of the *Canadian Aviation Regulations* in section 525.795 of the *Airworthiness Manual*. Subsection 701.30(1) of the CARs, which has been amended simultaneously, requires foreign air operators to comply with the enhanced aircraft security design standards for flight deck doors.

Change 525-9 **Published: June 1, 2003**

1. General

This change introduces a new amendment format. This new amendment format is introduced in Chapter 525 of the *Airworthiness Manual* in order to be more consistent with the administrative procedures followed to amend the *Canadian Aviation Regulations* (CARs).

The following changes to the amendment procedures are introduced in this Change 525-9:

• the preamble will be the focal point regarding the sections affected by this change. The change number will no longer be provided at the end of an amended section. Rather, for the current change only, the amended text will be followed by an amendment tag identifying the coming into force date of the provision.
(example: (amended 2003/06/01)).

• brackets " " will no longer be used to identify new or revised text. On the paper version, new or revised text will be highlighted. In the electronic version, new or revised text will not be highlighted, but followed by an electronic link to the previous version of the modified text.
(example: (amended 2003/06/01; previous version))

• the preamble will include tables of change information. These tables will include the Notices of Proposed Amendments (NPAs) with the corresponding amended sections.

2. FAR Amendments

This change incorporates the following amendments to the *United States Code of Federal Regulations*, Title 14, Chapter I, Part 25:

FAR Amendment 25-99 **Pending Publication**

***Information Note**: This amendment for Special Retroactive Requirements was not adopted using the simplified process for the amendment of the design standards of airworthiness by adopting by reference a foreign amendment. A Notice of proposed amendment was developed and presented to the CARAC Technical Committee Part V where it was recommended for acceptance. See section 3 "CARAC Recommendations" NPA 2000-241 for further information on this FAR amendment.*

FAR Amendment 25-100 **Effective: March 5, 2001**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2000-264	• 525.903 (Please note that the publication of this amended section has been deferred.) • 525.1091

This amendment revised the bird ingestion type certification standards for aircraft turbine engines to better address the actual bird threat encountered in service. This amendment also establishes nearly uniform bird ingestion standards for aircraft turbine engines certified by the United States under FAA standards and by the Joint Aviation Authorities (JAA) countries under JAA standards, thereby simplifying airworthiness approval for import and export. The adoption of this final rule harmonizes Canadian standards with FARs and JARs.

FAR Amendment 25-101 **Effective: May 7, 2001**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2001-004	• 525.1183

This amendment revises the airworthiness standards for transport category aeroplanes to establish a new requirement for fire protection of powerplant installations and requires that components within a designated fire zone must be fireproof if, when exposed to or damaged by fire, they could pose a hazard to the aeroplane. Also, the adoption of this final rule will harmonize Canadian standards with FARs and JARs without affecting current industry design practices.

FAR Amendment 25-102 **Effective: August 19, 2002**

Information Note*: Amendment 25-102, entitled "Transport Airplane Fuel Tank Design Review, Flammability Reduction, and Maintenance and Inspection Requirements" is not included in this change issue. This amendment, effective as of 19 August 2002, will be published in the next change.*

FAR Amendment 25-103 **Effective: October 1, 2001**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2001-251	• 525.473 • 525.723 • 525.725 • 525.727

This amendment revises the airworthiness standards for landing gear shock absorption test requirements for transport category aeroplanes by incorporating changes developed in cooperation with the U.S. Federal Aviation Administration (FAA), Joint Aviation Authorities (JAA) and the aviation industry through the Aviation Rulemaking Advisory Committee (ARAC). This amendment reduces the number of design wight conditions required to be demonstrated by shock absorption tests and changes the objective of the tests to include the complete validation of the landing gear dynamic characteristics. This amendment also removes some means of compliance criteria from the rule since it is more appropriately set forth in advisory material.

FAR Amendment 25-104 **Effective: October 24, 2001**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2001-254	• 525.1435

This amendment revises the hydraulic system design and test requirements of airworthiness standards for transport category aeroplanes. The amendment adds appropriate existing Joint Aviation Requirements (JAR) standards to achieve harmonization; moves some of the existing regulatory text to a new advisory circular (AC) 25.1435.1; consolidates and/or separates certain subparagraphs for clarity; and revises aeroplane static relief pressure. These revisions were developed in cooperation with Joint Aviation Authorities (JAA), Transport Canada, and the U.S. and European aviation industry through ARAC.

FAR Amendment 25-105 **Effective: October 1, 2001**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2001-255	• 525.1516 • 525.1527 • 525.1583 • 525.1585 • 525.1587

This amendment entitled "Revisions to Requirements Concerning Airplane Operating Limitations and the Content of Airplane Flight Manuals for Transport Category Airplanes" amends the airworthiness standards for transport category aeroplanes concerning aeroplane operating limitations and the content of aeroplane flight manuals. Issuing this amendment eliminates regulatory differences between the airworthiness standards of Canada, the U.S. and the Joint Aviation Authorities (JAA), without affecting current industry design practices.

FAR Amendment 25-106 **Effective: March 21, 2002**

***Information Note**: This is a special amendment, published at Change 8.1, that incorporates enhanced aircraft security design standards in support of amended regulations in CAR 705.80 required in the wake of the September 11, 2001 terrorist attacks and the issuance of SFAR 92-3 by the Federal Aviation Administration (FAA).*

3. CARAC Proposed Amendment Recommendations

This change implements the amendments to the standard recommended by the CARAC Technical Committee Part V.

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2001-011	• 525.1581

Therefore, this change includes the amendment to Canadian variation 525.1581*(e)*(1). This amendment deletes the requirement to have the Système Internationale (SI) units of measurement in the aircraft manual.

***Information Note**: FAR amendment 25-99 was presented as NPA 2000-241 to the Technical Committee. The NPA was reviewed at the September 6 and 7, 2000 meeting and was deferred at the November 16, 2000 meeting for further study and review accompanied with other NPAs that were drafted to deal with the Changed Product Rule (CPR). NPA 2000-241 was accepted at the November 16, 2000 meeting. The NPA will be published with the other related CPR NPAs when the CPR regulations will be implemented.*

1. General

This change introduces the Changed Product Rule into Chapter 525 of the *Airworthiness Manual* (AWM).

These amendments are required to address the trend toward fewer aeronautical products that are of completely new design and more products with multiple changes to previously approved designs for existing aeronautical products. In common with those of other major regulatory regimes, Canadian airworthiness regulations have permitted an individual or organization that had responsibility for the type design or a change to the type design of an aeronautical product to change aspects of the design of the aeronautical product without updating the design of the entire product to the design standards current at the time of the application for the change to the type design. The result could be, and often was, a series of changes to a design, over time, no one of which constituted an extensive change from the immediately preceding design. The cumulative effect of the series of changes, however, could result in a very different version of the aeronautical product from that version to which the original type certificate, which approved the original design, referred. As a result, many changed aeronautical products have not been required to demonstrate compliance with all the recent airworthiness design standards. The changes to Canadian regulations form part of an international agreement with the U.S. Federal Aviation Administration (FAA) and the European Joint Aviation Authorities (JAA) to harmonize procedures for aeronautical product design and certification to prevent the continuation of this situation.

The following Changed Product Rule Notice of Proposed Amendment (NPA) was presented to the Aircraft Certification Technical Committee of the Canadian Aviation Regulation Advisory Council (CARAC):

FAR Amendment 25-99 **Effective: June 5, 2003**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2001-241	• 525.2(c)

NPA 2000-241, which amended paragraph 525.2(c) to ensure that the new requirements for changes to type design that are introduced in Chapter 511 and 513 of the CARs will apply to Transport Category Aeroplanes. Compliance with subsequent revisions to the sections specified in paragraph (a) or (b) of section 525.2 of the AWM may be elected or may be required in accordance with subsection 511.13(1) and 513.07(1) of the CARs.

This amendment harmonizes the text of Chapter 525 of the *Airworthiness Manual* with the corresponding text of FAR 25 section 25.2 as amended by FAR amendment 25-99.

Change 525-10 **Effective: December 1, 2004**

In an effort to harmonize our regulatory guidance documents with those of other international aviation authorities and other branches within Transport Canada Civil Aviation (TCCA), the Aircraft Certification Branch has decided to replace existing Airworthiness Manual Advisories (AMA) related to certification of aeronautical products with new Advisory Circulars (AC). While the content of the new ACs will remain technically the same as the corresponding AMAs, which they will replace, the format of the ACs will be standardized to conform to other guidance documents published within the branch.

This change in guidance documentation becomes effective 1 December 2004 at which time the AMAs will be cancelled and replaced by their corresponding Advisory Circular concurrent with the next publishing of the Canadian Aviation Regulations (CAR). After this time, the CARAC Secretariat will no longer publish these AMAs and, consequently, ACs will not be published with their corresponding AWM Chapter. As of the 1 December 2004 issue of the CARs, any affected AMA references and content will have been removed. However, the AMA Index found in AMA 500/00 will, for now, continue to exist to provide a cross-reference between the old AMAs and the new ACs.

Change 525-11 **Published: December 1, 2005**

This change incorporates the following amendments to the United States Code of Federal Regulations, Title 14, Chapter I, Part 27:

FAR Correction **Effective: December 11, 2003**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2000-264 • 2003-256	• 525.903

NPA 2000-264 was written to adopt by reference Federal Aviation Regulation (FAR) amendment 25-100. The text of CAR Standard (*Airworthiness Manual*) paragraph 525.903(a)(2) in the NPA 2000-264 was erroneously written to include the term “and installation” in the opening statement of the subsection whereas the FAR text did not include this term. The contents of NPA 2003-256 supersede the contents of NPA 2000-264.

Additionally, the dates provided in subparagraphs 525.903(a)(2)(i), (ii) and (iii) of the current text are FAR effectives dates for respective section requirements. These FAR effective dates are not applicable in Canada. Consequently, the appropriate effective Canadian dates are provided to replace the FAR effective dates.

FAR Amendment 25-102 **Effective: August 19, 2002**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2002-043	• 525.981 • H525.4

FAR Amendment 25-103, 25-104, 25-105 and 25-106

See Change 525-9 for information regarding these amendments.

FAR Amendment 25-107 **Effective: November 10, 2003**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2003-211	• 525.731 • 525.735

This amendment revises the braking systems design and test requirements of the airworthiness standards for transport category aeroplane. The amendment moves some of the existing regulatory text, considered to be of an advisory nature, to an advisory circular (FAA AC 25.735-1) and adds regulations addressing automatic brake systems, brake wear indicators, pressure release devices, and system compatibility. FAA AC 25.735-1 has been published April 10, 2002 and is acceptable for use in Canada.

FAR Amendment 25-108 **Effective: November 10, 2003**

Table of Change Information		
Notice of Proposed Amendment	**Amended Section(s)**	
• 2003-212	• 525.103 • 525.107 • 525.111 • 525.119 • 525.121 • 525.125 • 525.143 • 525.145 • 525.147 • 525.149 • 525.161 • 525.175	• 525.177 • 525.181 • 525.201 • 525.207 • 525.231 • 525.233 • 525.237 • 525.773 • 525.1001 • 525.1323 • 525.1325 • 525.1587

This amendment entitled "1-g Stall Speed as the basis for Compliance" amends the airworthiness standards for transport category aeroplanes to redefine the reference stall speed for transport category aeroplanes as a speed not less than the 1-g stall speed instead of the minimum speed obtained in a stalling manoeuvre. This amendment will provide a higher level of safety for those cases in which the current methods result in artificially low operating speeds.

FAR Amendment 25-109 **Effective: November 10, 2003**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2003-213	o 525.1323

This amendment entitled "Airspeed Indicating System Requirements for Transport Category Aeroplanes" amends the airworthiness standards for transport category aeroplanes concerning airspeed indicating system requirements. The amendment adds airspeed indication requirements for speeds greater than and less than the speed range for which airspeed indication accuracy requirements currently apply; a requirement that airspeed indications not cause the pilot undue difficulty between the initiation of rotation and the achievement of a steady climbing condition during takeoff, and a requirement to limit the effects airspeed lag.

FAR Amendment 25-110 **Effective: November 30, 2003**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2003-254	• 525.819

This amendment entitled "Lower Deck Service Compartment of Transport Category Aeroplanes" amends the airworthiness standards for transport category aeroplanes equipped with lower deck service compartments that are not certificated to be occupied during takeoff and landing. This amendment requires that two-way voice communication systems between lower and deck service compartments and flight deck remain available following loss of normal electrical power generating system, and seats installed in the lower deck compartment meet the requirements of AWM 525.785(d) instead of AWM 525.785(c).

Change 525-12 **Published: December 30, 2006**

This change incorporates the following amendments to the United States Code of Federal Regulations, Title 14, Chapter I, Part 25:

FAR Amendment 25-111 **Effective: June 8, 2004**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2004-028	• 525.856 • Appendix F, Parts I, VI and VII

This Amendment entitled "Improved Flammability Standards for Thermal/Acoustic Insulation Materials Used in Transport Category Airplanes" revises the flammability standards for thermal and acoustic insulation materials. The revised standards include new flammability tests and criteria that address flame propagation and entry of an external fire into the aeroplane. This is necessary because the current standards do not realistically address situations in which thermal or acoustic insulation materials may contribute to the propagation of a fire. The revised standards intend to enhance safety by reducing the incidence and severity of cabin fires, particularly those in inaccessible areas where thermal and acoustic insulation materials are installed and also by providing additional time for evacuation by delaying the entry of external post crash fires into the cabin.

FAR Amendment 25-112 **Effective: November 26, 2003**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2003-255	• 525.613

This amendment entitled "Material strength properties and design values for transport aeroplanes" amends the airworthiness standards for transport category aeroplanes concerning material strength properties and design values requirements. Issuing this amendment eliminates a regulatory difference between the airworthiness standards of Canada, the U.S. and Joint Aviation Authorities of Europe, without affecting current industry design practices.

This amendment revises the heading and paragraphs (b) and (d) to clarify that the design values are material design values.

This amendment also requires consideration of environmental conditions in general, such as temperature and moisture, on material design values used in an essential component or structure, where those effects are significant in the aeroplane operating envelope.

This amendment removes paragraph (d) as fatigue is now adequately addressed in AWM 525.571 and adds paragraph (f), which permits the use of other design values if approved by the Minister.

FAR Amendment 25-113 **Effective: July 16, 2004**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2004-041	• 525.869 • 525.1353 • 525.1431

This amendment amends the airworthiness standards for transport category aeroplanes concerning electrical equipment, nickel cadmium battery installation and storage, electrical cables, design and installation of electronic equipment and fire protection of electrical system components. Adoption of this amendment eliminates significant regulatory differences between the airworthiness standards of Canada, the U.S. and the Joint Aviation Authorities of Europe, without affecting current industry design practices.

Change 525-13 **Published: June 30, 2007**

This change incorporates the following amendments to the United States Code of Federal Regulations, Title 14, Chapter I, Part 25:

FAR Amendment 25-114 **Effective: March 8, 2007**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2006-005	• 525.783 • 525.807 • 525.809 • 525.810 • 525.820

This amendment entitled "Design Standards for Fuselage Doors on Transport Category Aeroplanes" changes the design standards for fuselage doors, hatches, and exits on transport category aeroplanes. It provides design criteria that ensure doors remain secure under all circumstances that service experience has shown can happen.

FAR Amendment 25-115 **Effective: June 3, 2005**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2005-013	• 525.111 • 525.147 • 525.161 • 525.175 • 525.677 • 525.945 • 525.973 • 525.1141 • 525.1181 • 525.1305 • 525.1423 • 525.1439

This amendment entitled "Miscellaneous Flight Requirements; Powerplant Installation Requirements; Public Address System; Trim Systems and Protective Breathing Equipment; and Powerplant Controls" amends the airworthiness standards for transport category aeroplanes in each of these six areas.

FAR Amendment 25-116 **Effective: March 8, 2007**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2006-010	• 525.809 • 525.812 • 525.813 • 525.853 • 525.855 • 525.1411 • 525.1447

The amendment entitled "Miscellaneous Cabin Safety Changes" changes the airworthiness standards for transport category aeroplanes relating to flight attendant assist spaces and handles, door hold-open features, outside viewing means, interior compartment doors, and portable oxygen equipment. These amendments are part of a continuing effort to upgrade the standards to improve the overall level of safety in areas where the state-of-the-art and good design practice have indicated that such upgrades are warranted.

FAR Amendment 25-117 **Effective: March 8, 2007**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2006-007	• Appendix J

The amendment entitled "Revision of Emergency Evacuation Demonstration Procedures To Improve Participant Safety" amends the emergency evacuation demonstration procedures requirements for transport category aeroplanes to allow certain alternative procedures in conducting full-scale emergency evacuation demonstrations, reducing the possibility of injury to participants.

Change 525-14 **Published: December 30, 2007**

This change incorporates the following amendments based on the United States *Code of Federal Regulations*, *Title 14*, *Chapter I*, *Part 25*:

Aeroplane Flight Manual **Effective: July 16, 2007**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2007-017	• 525.1581

The amendment entitled "*Aeroplane Flight Manual*" amends the current AWM paragraph 525.1581(a)(3), which makes reference to AWM Chapter 516, 2nd Edition, whereas the 2nd Edition is no longer applicable for new aeronautical product approvals. The reference to 2nd Edition is thus deleted, meaning that the current change level of AWM 516 will be the applicable noise and emission standard. This change will allow this provision to remain harmonized with FAR part 25.

FAR Amendment 25-119 **Effective: July 16, 2007**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2007-020	• 525.1329 • 525.1335

Proposed adoption by reference of FAR Amendment 25-119 dated May 11, 2006 and incorporation of the FAA Final Rule in Chapter 525 of the *Airworthiness Manual*.

The amendment entitled "*Safety Standards for Flight Guidance System*" amends the airworthiness standards for new designs and significant product changes for transport category aeroplanes concerning flight guidance systems. The standards address the performance, safety,

failure protection, alerting, and basic annunciation of these systems. This amendment addresses flight guidance system vulnerabilities and consolidates and standardizes regulations for functions within those systems. In addition, this amendment updates the current standards regarding the latest technology and functionality. Adopting this amendment eliminates significant regulatory differences between Canadian, U.S. and European airworthiness standards.

Change 525-15 **Published: December 30, 2008**

1. Corrections (Ground Gust Conditions)

AWM 525.415(b) has been corrected with respect to the requirements provided in the table for values of "K" and "Position of Controls". Typographical errors appeared in the published version during transition to the CARs format at Change 525-7 as well as to the Internet and CD-ROM format at Change 525-8. AWM 525.415(b) remains a requirement with no variation as compared to §25.415(b) of the FAR, as has been the case since the First Edition of AWM Chapter 525, effective July 1, 1986.

2. FAR Amendments

This change incorporates the following amendment to the United States Code of Federal Regulations, Title 14, Chapter I, Part 25:

***Information Note**: FAR Amendment 25-120, entitled "Extended Operations (ETOPS) of Multi-Engine Airplanes" is not adopted in Canada at this time as. TP 6327, Safety Criteria For Approval of Extended Range Twin-Engine Operations (ETOPS), is published by Transport Canada Safety and Security under the authority of the Director General, Civil Aviation by the Director, Commercial and Business Aviation in co-ordination with the Director, Aircraft Certification and the Director, Maintenance and Manufacturing.*

FAR Amendment 25-121 **Effective: October 30, 2008**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2008-002	• 525.21 • 525.103 • 525.105 • 525.107 • 525.111 • 525.119 • 525.121 • 525.123 • 525.125 • 525.143 • 525.207 • 525.237 • 525.253 • 525.773 • 525.941 • 525.1419 • Appendix C

This amendment entitled "Airplane Performance and Handling Qualities in Icing Conditions" introduces new airworthiness standards to evaluate the performance and handling characteristics of transport category aeroplanes in icing conditions. This action will improve the level of safety for new aeroplane designs when operating in icing conditions.

FAR Amendment 25-122 **Effective: October 30, 2008**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2008-003	• 525.1317 • Appendix L

This amendment entitled "High-Intensity Radiated Fields (HIRF) Protection for Aircraft Electrical and Electronic Systems" revises the airworthiness standards for Transport Category Aeroplanes. This action is necessary due to the vulnerability of aircraft electrical and electronic systems and the increasing use of high-power radio frequency transmitters. It is intended to create a safer operating environment for civil aviation by protecting aircraft and their electrical and electronic systems from the adverse effects of HIRF.

Change 525-16 **Published: June 30, 2009**

This change incorporates the following amendment to the United States Code of Federal Regulations, Title 14, Chapter I, Part 25:

FAR Amendment 25-123 **Effective: May 11, 2009**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2008-013	• 525.611 • 525.855 • 525.869 • 525.899 • 525.1203 • 525.1301 • 525.1309 • 525.1310 • 525.1353 • 525.1357 • 525.1360 • 525.1362 • 525.1365 • 525.1701 • 525.1703 • 525.1705 • 525.1707 • 525.1709 • 525.1711 • 525.1713 • 525.1715 • 525.1717 • 525.1719 • 525.1721 • 525.1723 • 525.1725 • 525.1727 • 525.1729 • 525.1731 • 525.1733 • Appendix H

This Amendment entitled "Enhanced Airworthiness Program for Airplane Systems/Fuel Tank Safety (EAPAS/FTS)" amends the airworthiness standards for transport category aeroplanes. It ensures the continued safety of transport category aeroplanes by improving the design, installation and maintenance of aeroplane electrical wiring systems and align those requirements as closely as possible with the requirements for fuel tank system safety. This

amendment organizes and clarifies design requirements for wire systems by moving existing regulatory references to wiring into a single subchapter of the Airworthiness Manual Chapter 525 specifically for wiring and by adding new certification standards.

FAR Amendment 25-124 **Effective: May 11, 2009**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2008-067	• 525.1457 • 525.1459

This Amendment entitled "Revisions to Cockpit Voice Recorder and Digital Flight Data Recorder Standards" amends cockpit voice recorder (CVR) and digital flight data recorder (DFDR) design standards. This amendment increases the duration of certain CVR recordings, requires physical separation of the DFDR and CVR, improves the reliability of the power supplies to both the CVR and DFDR, and requires that certain datalink communications received on an aircraft be recorded if datalink communication equipment is installed. This amendment is based on recommendations issued by the National Transportation Safety Board following its investigations of several accidents and incidents. These changes to CVR and DFDR systems are intended to improve the quality and quantity of information recorded, and increase the potential for retaining important information needed for accident and incident investigations.

FAR Amendment 25-125 **Effective: May 11, 2009**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2008-164	• 525.981 • Appendix M • Appendix N

This Amendment entitled "Reduction of Fuel Tank Flammability" requires that the design should be such as to reduce the chances of a catastrophic fuel tank explosion. This amendment does not direct the adoption of specific inerting technology, but establishes a performance-based set of requirements that set acceptable flammability exposure values in tanks most prone to explosion or require the installation of an ignition mitigation means in an affected fuel tank. Technology now provides commercially feasible methods to accomplish this safety objective.

Change 525-17 **Published: December 1, 2009**

On December 1, 2009, Part V Subpart 21 of the *Canadian Aviation Regulations* (CAR 521) came into force. CAR 521 replaces the following Regulations in Part V—Airworthiness:

Subpart 11 - Approval of the Type Design of an Aeronautical Product

Subpart 13 - Approval of Modification and Repair Designs

Subpart 16 - Aircraft Emissions

Subpart 22 - Gliders and Powered Gliders

Subpart 23 - Normal, Utility, Aerobatic and Commuter Category Aeroplanes

Subpart 25 - Transport Category Aeroplanes

Subpart 27 - Normal Category Rotorcraft

Subpart 29 - Transport Category Rotorcraft

Subpart 31 - Manned Free Balloons

Subpart 33 - Aircraft Engines

Subpart 35 - Aircraft Propellers

Subpart 37 - Aircraft Appliances and Other Aeronautical Products

Subpart 41 - Airships

Subpart 51 - Aircraft Equipment

Subpart 91 - Service Difficulty Reporting

Subpart 93 - Airworthiness Directives

In addition, with publication of CAR 521, the following Chapters of the Airworthiness Manual have been withdrawn:

Chapter 511 - Approval of the Type Design of an Aeronautical Product

Chapter 513 - Approval of Modification and Repair Designs

Standard 591 - Service Difficulty Reporting

Standard 593 - Airworthiness Directives

This change amends sections 525.1 and 525.2 to reflect changes in legal drafting style, in terminology and in references required because of the introduction of CAR 521. In addition, subsection 521.31(1) of the CARs is now used to legally enable this Chapter of the AWM.

Change 525-18 **Published: June 1, 2010**

This Change incorporates the following amendments to the United States Code of Federal Regulations, Title 14, Chapter I, Part 25:

FAR Amendment 25-126 **Effective: January 29, 2010**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2009-013	• 525.901 • 525.905 • 525.907

This amendment entitled "Airworthiness Standards; Propellers" addressed advances in propeller technology of the past twenty years and not previously adequately addressed in the standards. The new standards address these advances in technology and harmonize Transport Canada Civil Aviation (TCCA), Federal Aviation Administration (FAA) and European Aviation Safety Agency (EASA) propeller certification requirements, thereby simplifying airworthiness approvals for imports and exports. This amendment modifies 525.901(b), 525.905(c), 525.907(a) and (b), and adds 525.907(c).

Change 525-19 **Published: December 1, 2010**

This Change incorporates the following amendments to the United States Code of Federal Regulations, Title 14, Chapter I, Part 25:

FAR Amendment 25-127 **Effective: June 16, 2010**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2009-017	• 525.795

This amendment entitled "Security Related Considerations in the Design and Operation of Transport Category Aeroplanes" adopts several standards of the International Civil Aviation Organization (ICAO) and requires manufacturers to incorporate certain security features in the design of new transport category aeroplanes. Specifically, manufacturers of affected aeroplanes must design flight decks that are protected from penetration by projectiles and intrusion by unauthorized persons. The flight deck, passenger cabin and cargo compartments of these aeroplanes must be protected from the effects of detonation of an explosive or incendiary device. The rule also requires that manufacturers of new transport category aeroplanes design a "least risk bomb location" and that operators of certain existing aeroplanes designate such a location.

Change 525-20 **Published: June 1, 2012**

This change incorporates one correction to the *Airworthiness Manual* and adopts six amendments to the *United States Code of Federal Regulations, Chapter I, Part 25*:

Correction (Design Airspeed) **Effective: March 27, 2012**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2010-024	• 525.335

This amendment makes a correction to section 525.335 of the *Airworthiness Manual* (AWM), which is missing text in paragraph 525.335(a)(1). The paragraph under the title of "Design Airspeed" shows the missing text incorrectly introduced at Change 525-7 published September 30, 1996. Accordingly, a correction to paragraph 525.335(a)(1) of the **English** version only of the AWM is presented.

FAR Amendments
FAR Technical Amendment 25-128 **Effective: March 27, 2012**
Correction

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2010-023	• 525.812 • Appendix F, Part VII

This amendment corrects a number of errors in the safety standards for transport category aeroplanes. None of the changes are substantive in nature, and this amendment will not impose any additional burdens on any person affected by these regulations.

A number of unrelated errors in the safety standards for transport category aeroplanes have been brought to the attention of the FAA. Some are due to inadvertent omissions or other editing errors; others are simply typographical or printing errors.

FAR Amendment 25-130 **Effective: March 27, 2012**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2010-027	• 525.1583

This NPA entitled "Manoeuvring Speed Limitation Statement" clarifies that flying at or below the design manoeuvring speed does not allow a pilot to make multiple large control

inputs in one aeroplane axis or single full control inputs in more than one aeroplane axis at a time without endangering the aeroplane's structure. The FAA is issuing this final rule to prevent pilots from misunderstanding the meaning of an aeroplane's manoeuvring speed, which could cause or contribute to a future accident.

FAR Amendment 25-131 **Effective: March 27, 2012**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2011-012	• 525.1322

This amendment entitled "Flight Crew Alerting" addresses the airworthiness standards for transport category aeroplanes concerning flight crew alerting. These standards update definitions, prioritization, colour requirements, and performance for flight crew alerting to reflect changes in technology and functionality. This amendment adds additional alerting functions and consolidates and standardizes definitions and regulations for flight crew warning, caution, and advisory alerting systems. This action will result in harmonized standards among Transport Canada Civil Aviation, the Federal Aviation Administration and the European Aviation Safety Agency.

FAR Amendment 25-132 **Effective: March 27, 2012**

Table of Change Information	
Notice of Proposed Amendment	**Amended Section(s)**
• 2011-013	• 525.571 • Appendix H

This amendment entitled "Aging Airplane Program: Widespread Fatigue Damage" pertaining to certification and operation of transport category aeroplanes is to prevent widespread fatigue damage in those aeroplanes.

In an effort to prevent catastrophic events due to Widespread Fatigue Damage (WFD), new rules are being proposed that would require design approval holders to establish limits of validity of the maintenance schedule (structures aspects) on the operation of transport category aeroplanes. Design approval holders would also be required to determine if maintenance actions are required to prevent WFD before the design service goal is reached, or where the design service goal has already been reached by the high-time aeroplane, by a specified date. This change to the *Airworthiness Manual* requires applicants for design approvals for transport category aeroplanes to perform the following actions: Establish a *limit of validity* (LOV) of the engineering data that supports the structural maintenance program; demonstrate that WFD will not occur in the aeroplane prior to reaching the LOV; and establish or revise the

Airworthiness Limitations section in the Instructions for Continued Airworthiness (ICA) to include the LOV.

This amendment is one of the regulatory amendments associated with implementing the *Aging Aircraft Program* initiatives within the *Canadian Aviation Regulations* and the standards of the *Airworthiness Manual*. Other proposed amendments will be coordinated in separate NPAs.

PART V - AIRWORTHINESS

AIRWORTHINESS MANUAL CHAPTER 525 — TRANSPORT CATEGORY AEROPLANES

(2001/06/01)

SUBCHAPTER A

General

525.1 ***Applicability***

(a) This Chapter sets out airworthiness standards for the issuance of type certificates and changes to type certificates, for transport category aeroplanes.
(amended 2009/12/01)

(b) Reserved.
(amended 2009/12/01)

(Change 525-3 (91-11-01))
(Change 525-7 (96-09-30))
(Change 525-8)

525.2 ***Special Retroactive Requirements***

The following special retroactive requirements are applicable to an aeroplane for which the standards referenced in the type certificate or in an equivalent document based on which the Minister has issued a Certificate of Airworthiness, predate the sections of the Code of Federal Regulations of the United States of America, Title 14, Chapter 1, Part 25, which are specified hereafter:

FAR:

The following special retroactive requirements are applicable to an airplane for which the regulations referenced in the type certificate predate the sections specified below:

(a) Irrespective of the date of application, each applicant for a supplemental type certificate (or an amendment to a type certificate) involving an increase in passenger seating capacity to a total greater than that for which the aeroplane has been type certificated must show that the aeroplane concerned meets the requirements of:

(1) FAR sections 25.721(d), 25.783(g), 25.785(c), 25.803(c)(2) through (9), 25.803(d) and (e), 25.807(a), (c) and (d), 25.809(f) and (h), 25.811, 25.812, 25.813(a), (b) and (c), 25.815, 25.817, 25.853(a) and (b), 25.855(a), 25.993(f) and 25.1359(c), in effect on October 24, 1967, and
(amended 2009/12/01)

(2) FAR sections 25.803(b) and (c)(1) in effect on April 23, 1969.

(b) Irrespective of the date of application, each applicant for a supplemental type certificate (or an amendment to a type certificate) for an aeroplane manufactured after October 16, 1987,

must show that the aeroplane meets the requirements of FAR 25.807(c)(7) in effect on July 24, 1989.

Note: The requirements of FAR 25.807(c)(7), in effect on July 24, 1989, are those published by the Federal Aviation Administration of the United States of America at amendment 25-67.

(c) Compliance with subsequent revisions to the sections specified in paragraph (a) or (b) above may be elected or may be required in accordance with Division IV of Part V, Subpart 21 of the *Canadian Aviation Regulations*.
(amended 2009/12/01)

FAR:

(c) Compliance with subsequent revisions to the sections specified in paragraph (a) or (b) above may be elected in accordance with §21.101(a)(2) of this chapter or may be required in accordance with §21.101(b) of this chapter.

(Change 525-3 (91-11-01))
(Change 525-8)

SUBCHAPTER B

Flight - General

525.21 *Proof of Compliance*

(a) Each requirement of this subchapter must be met at each appropriate combination of weight and centre of gravity within the range of loading conditions for which certification is requested. This must be shown:

(1) By tests upon an aeroplane of the type for which certification is requested, or by calculations based on, and equal in accuracy to, the results of testing; and

(2) By systematic investigation of each probable combination of weight and centre of gravity, if compliance cannot be reasonably inferred from combinations investigated.

(b) (Reserved)

(c) The controllability, stability, trim, and stalling characteristics of the aeroplane must be shown for each altitude up to the maximum expected in operation.

(d) Parameters critical for the test being conducted, such as weight, loading (centre of gravity and inertia), airspeed, power, and wind, must be maintained within acceptable tolerances of the critical values during flight testing.

(e) If compliance with the flight characteristics requirements is dependent upon a stability augmentation system or upon any other automatic or power-operated system, compliance must be shown with 525.671 and 525.672.

(f) In meeting the requirements of 525.105*(d)*, 525.125, 525.233, and 525.237, the wind velocity shall be measured at a height of 10 metres above the surface, or corrected for the difference between the height at which the wind velocity is measured and the 10-metre height.
(amended 2008/10/30)

(g) The requirements of this subchapter associated with icing conditions apply only if the applicant is seeking certification for flight in icing conditions.
(amended 2008/10/30)

(1) Each requirement of this subchapter, except 525.121(a), 525.123(c), 525.143(b)(1) and (b)(2), 525.149, 525.201(c)(2), 525.207(c) and (d), 525.239, and 525.251(b) through (e), shall be met in icing conditions. Compliance shall be shown using the ice accretions defined in Appendix C, assuming normal operation of the aeroplane and its ice protection system in accordance with the operating limitations and operating procedures established by the applicant and provided in the *Aeroplane Flight Manual.*
(amended 2008/10/30)

(2) No changes in the load distribution limits of 525.23, the weight limits of 525.25 (except where limited by performance requirements of this subchapter), and the center of gravity limits of 525.27, from those for non-icing conditions, are allowed for flight in icing conditions or with ice accretion.
(amended 2008/10/30)

(Change 525-3 (91-11-01))

525.23 *Load Distribution Limits*

(a) Ranges of weights and centres of gravity within which the aeroplane may be safely operated must be established. If a weight and centre of gravity combination is allowable only within certain load distribution limits (such as spanwise) that could be inadvertently exceeded, these limits and the corresponding weight and centre of gravity combinations must be established.

(b) The load distribution limits may not exceed:

(1) The selected limits;

(2) The limits at which the structure is proven; or

(3) The limits at which compliance with each applicable flight requirement of this subchapter is shown.

525.25 *Weight Limits*

(a) Maximum weights. Maximum weights corresponding to the aeroplane operating conditions (such as ramp, ground or water taxi, take-off, en route, and landing) environmental conditions (such as altitude and temperature), and loading conditions (such as zero fuel weight, centre of gravity position and weight distribution) must be established so that they are not more than:

(1) The highest weight selected by the applicant for the particular conditions; or

(2) The highest weight at which compliance with each applicable structural loading and flight requirement is shown, except that for aeroplanes equipped with standby power rocket engines the maximum weight must not be more than the highest weight established in accordance with Appendix E of this chapter; or

(3) The highest weight at which compliance is shown with the certification requirements of chapter 516, Subchapter A of this manual.

(b) Minimum weight. The minimum weight (the lowest weight at which compliance with each applicable requirement of this chapter is shown) must be established so that it is not less than:

(1) The lowest weight selected by the applicant;

(2) The design minimum weight (the lowest weight at which compliance with each structural loading condition of this chapter is shown); or

(3) The lowest weight at which compliance with each applicable flight requirement is shown.

(Change 525-2 (89-01-01))

525.27 *Centre of Gravity Limits*

The extreme forward and the extreme aft centre of gravity limitations must be established for each practicably separable operating condition. No such limit may lie beyond:

(a) The extremes selected by the applicant;

(b) The extremes within which the structure is proven; or

(c) The extremes within which compliance with each applicable flight requirement is shown.

525.29 *Empty Weight and Corresponding Centre of Gravity*

(a) The empty weight and corresponding centre of gravity must be determined by weighing the aeroplane with:

(1) Fixed ballast;

(2) Unusable fuel determined under 525.959; and

(3) Full operating fluids, including:

(i) Oil;

(ii) Hydraulic fluid; and

(iii) Other fluids required for normal operation of aeroplane systems, except potable water, lavatory precharge water, and fluids intended for injection in the engine.

(b) The condition of the aeroplane at the time of determining empty weight must be one that is well defined and can be easily repeated.

(Change 525-3 (91-11-01))

525.31 *Removable Ballast*

Removable ballast may be used in showing compliance with the flight requirements of this subchapter.

525.33 *Propeller Speed and Pitch Limits*

(a) The propeller speed and pitch must be limited to values that will ensure:

(1) Safe operation under normal operating conditions; and

(2) Compliance with the performance requirements in 525.101 through 525.125.

(b) There must be a propeller speed limiting means at the governor. It must limit the maximum possible governed engine speed to a value not exceeding the maximum allowable r.p.m.

(c) The means used to limit the low pitch position of the propeller blades must be set so that the engine speed does not exceed 103 percent of the maximum allowable engine r.p.m. or 99 percent of an approved maximum overspeed whichever is greater with:

(1) The propeller blades at the low pitch limit and governor inoperative;

(2) The aeroplane stationary under standard atmospheric conditions with no wind; and

(3) The engines operating at the take-off manifold pressure limit for reciprocating engine powered aeroplanes or the maximum take-off torque limit for turbopropeller engine-powered aeroplanes.

(Change 525-3 (91-11-01))

Performance

525.101 *General*

(a) Unless otherwise prescribed, aeroplanes must meet the applicable performance requirements of this subchapter for ambient atmospheric conditions and still air.

(b) The performance, as affected by engine power or thrust, must be based on the following relative humidities:

(1) For turbine engine powered aeroplanes, a relative humidity of:

(i) 80 percent, at and below standard temperatures; and

(ii) 34 percent, at and above standard temperatures plus 50 degrees F.

Between these two temperatures, the relative humidity must vary linearly.

(2) For reciprocating engine powered aeroplanes, a relative humidity of 80 percent in a standard atmosphere. Engine power corrections for vapour pressure must be made in accordance with the following table:

Altitude H (ft.)	Vapour Pressure "e"		Specific Humidity W (lb. moisture per lb. dry air)	Density Ratio σ=ρ/0.0023769
	(in. Hg.)	(mb)		
0	0.403	(13.64)	0.00849	0.99508
1,000	0.354	(11.98)	0.00773	0.96672
2,000	0.311	(10.53)	0.00703	0.93895
3,000	0.272	(9.21)	0.00638	0.91178
4,000	0.238	(8.06)	0.00578	0.88514
5,000	0.207	(7.00)	0.00523	0.85910
6,000	0.1805	(6.11)	0.00472	0.83361
7,000	0.1566	(5.30)	0.00425	0.80870
8,000	0.1356	(4.59)	0.00382	0.78434
9,000	0.1172	(3.97)	0.00343	0.76053
10,000	0.1010	(3.42)	0.00307	0.73722
15,000	0.0463	(1.57)	0.001710	0.62868
20,000	0.01978	(0.67)	0.000896	0.53263
25,000	0.00778	(0.26)	0.000436	0.44806

(c) The performance must correspond to the propulsive thrust available under the particular ambient atmospheric conditions, the particular flight condition, and the relative humidity specified in paragraph *(b)* of this section. The available propulsive thrust must correspond to engine power or thrust, not exceeding the approved power or thrust, less:

(1) Installation losses; and

(2) The power or equivalent thrust absorbed by the accessories and services appropriate to the particular ambient atmospheric conditions and the particular flight condition.

(d) Unless otherwise prescribed, the applicant must select the take-off, en route, approach, and landing configurations for the aeroplane.

(e) The aeroplane configurations may vary with weight, altitude, and temperature, to the extent they are compatible with the operating procedures required by paragraph *(f)* of this section.

(f) Unless otherwise prescribed, in determining the accelerate-stop distances, take-off flight paths, take-off distances, and landing distances, changes in the aeroplane's configuration, speed, power, and thrust, must be made in accordance with procedures established by the applicant for operation in service.

(g) Procedures for the execution of balked landings and missed approaches associated with the conditions prescribed in 525.119 and 525.121*(d)* must be established.

(h) The procedures established under paragraphs *(f)* and *(g)* of this section must:

(1) Be able to be consistently executed in service by crews of average skill;

(2) Use methods or devices that are safe and reliable; and

(3) Include allowance for any time delays, in the execution of the procedures, that may reasonably be expected in service.

(i) The accelerate-stop and landing distances prescribed in 525.109 and 525.125, respectively, must be determined with all the aeroplane wheel brake assemblies at the fully worn limit of their allowable wear range.

(Change 525-8)

525.103 *Stall Speed*

(amended 2003/11/10)

(a) The reference stall speed, V_{SR}, is a calibrated airspeed defined by the applicant. V_{SR} may not be less than a 1-g stall speed. V_{SR} is expressed as:
(amended 2003/11/10)

$$V_{SR} \geq \frac{V_{CL_{MAX}}}{\sqrt{n_{ZW}}}$$

Where:
(amended 2003/11/10)

V_{CLMAX}= Calibrated airspeed obtained when the load factor-corrected lift coefficient

$$\left(\frac{n_{ZW}\ W}{qS}\right)$$

is first a maximum during the manoeuvre prescribed in paragraph (c) of this section. In addition, when the manoeuvre is limited by a device that abruptly pushes the nose down at a selected angle of attack (e.g., a stick pusher), V_{CLMAX} may not be less than the speed existing at the instant the device operates;

n_{ZW}= Load factor normal to the flight path at V_{CLMAX}

W= Aeroplane gross weight;

S= Aerodynamic reference wing area; and

q= Dynamic pressure.

(b) V_{CLMAX} is determined with:
(amended 2003/11/10)

(1) Engines idling, or, if that resultant thrust causes an appreciable decrease in stall speed, not more than zero thrust at the stall speed;
(amended 2003/11/10)

(2) Propeller pitch controls (if applicable) in the take-off position;
(amended 2003/11/10)

(3) The aeroplane in other respects (such as flaps, landing gear and ice accretions) in the condition existing in the test or performance standard in which V_{SR} is being used;
(amended 2008/10/30)

(4) The weight used when V_{SR} is being used as a factor to determine compliance with a required performance standard;
(amended 2003/11/10)

(5) The center of gravity position that results in the highest value of reference stall speed; and
(amended 2003/11/10)

(6) The aeroplane trimmed for straight flight at a speed selected by the applicant, but not less than $1.13V_{SR}$ and not greater than $1.3V_{SR}$.
(amended 2003/11/10)

(c) Starting from the stabilized trim condition, apply the longitudinal control to decelerate the aeroplane so that the speed reduction does not exceed one knot per second.
(amended 2003/11/10)

(d) In addition to the requirements of paragraph *(a)* of this section, when a device that abruptly pushes the nose down at a selected angle of attack (e.g., a stick pusher) is installed, the reference stall speed, V_{SR}, may not be less than 2 knots or 2 percent, whichever is greater, above the speed at which the device operates.
(amended 2003/11/10)

525.105 *Take-off*

(a) The take-off speeds prescribed by 525.107, the accelerate-stop distance prescribed by 525.109, the take-off path prescribed by 525.111, and the take-off distance and take-off run prescribed by 525.113, and the net take-off flight path prescribed by 525.115 shall be determined in the selected configuration for take-off at each weight, altitude and ambient temperature within the operational limits selected by the applicant:
(amended 2008/10/30)

(1) in non-icing conditions; and
(amended 2008/10/30)

(2) In icing conditions, if in the configuration of 525.121(b) with the take-off ice accretion defined in Appendix C:
(amended 2008/10/30)

(i) The stall speed at maximum take-off weight exceeds that in non-icing conditions by more than the greater of 3 knots CAS or 3 percent of VSR; or
(amended 2008/10/30)

(ii) The degradation of the gradient of climb determined in accordance with 525.121(b) is greater than one-half of the applicable actual-to-net take-off flight path gradient reduction defined in 525.115(b).
(amended 2008/10/30)

(b) No take-off made to determine the data required by this section may require exceptional piloting skill or alertness.

(c) The take-off data must be based on:

(1) In the case of land planes and amphibians:

(i) Smooth, dry and wet, hard-surfaced runways; and

(ii) At the option of the applicant, grooved or porous friction course wet, hard-surfaced runways.

(2) Smooth water, in the case of seaplanes and amphibians; and

(3) Smooth, dry snow, in the case of skiplanes.

(d) The take-off data must include, within the established operational limits of the aeroplane, the following operational correction factors:

(1) Not more than 50 percent of nominal wind components along the take-off path opposite to the direction of take-off, and not less than 150 percent of nominal wind components along the take-off path in the direction of take-off.

(2) Effective runway gradients.

(Change 525-2 (89-01-01))
(Change 525-8)

525.107 *Take-off Speeds*

(a) V_1 must be established in relation to V_{EF} as follows:

(1) V_{EF} is the calibrated air speed at which the critical engine is assumed to fail. V_{EF} must be selected by the applicant, but may not be less than V_{MCG} determined under 525.149(e).

(2) V_1, in terms of calibrated airspeed, is selected by the applicant; however, V_1 may not be less than V_{EF} plus the speed gained with the critical engine inoperative during the time interval between the instant at which the critical engine is failed, and the instant at which the pilot recognises and reacts to the engine failure, as indicated by the pilot's initiation of the first action (e.g., applying brakes, reducing thrust, deploying speed brakes) to stop the aeroplane during accelerate-stop tests.

(b) V_{2min}, in terms of calibrated airspeed, may not be less than:

(1) 1.13 V_{SR} for:
(amended 2003/11/10)

(i) Two-engine and three-engine turbo-propeller and reciprocating engine powered aeroplanes; and

(ii) Turbojet powered aeroplanes without provisions for obtaining a significant reduction in the one-engine-inoperative power-on stall speed;
(amended 2003/11/10)

(2) 1.08 V_{SR} for:
(amended 2003/11/10)

(i) Turbopropeller and reciprocating engine powered aeroplanes with more than three engines; and

(ii) Turbojet powered aeroplanes with provisions for obtaining a significant reduction in the one-engine-inoperative power-on stall speed ; and
(amended 2003/11/10)

(3) 1.10 times V_{MC} established under 525.149.

(c) V_2, in terms of calibrated airspeed, shall be selected by the applicant to provide at least the gradient of climb required by 525.121*(b)* but shall not be less than:
(amended 2008/10/30)

(1) V_{2min};

(2) V_R plus the speed increment attained (in accordance with 525.111(c)(2)) before reaching a height of 35 feet above the take-off surface; and

(3) A speed that provides the manoeuvring capability specified in 525.143(h).
(amended 2008/10/30)

(d) V_{MU} is the calibrated airspeed at and above which the aeroplane can safely lift off the ground, and continue the take-off. V_{MU} speeds must be selected by the applicant throughout the range of thrust-to-weight ratios to be certificated. These speeds may be established from free air data if these data are verified by ground take-off tests.

(e) V_R, in terms of calibrated airspeed, must be selected in accordance with the conditions of subparagraphs (1) through (4) of this paragraph:

(1) V_R may not be less than:

(i) V_1;

(ii) 105 percent of V_{MC};

(iii) The speed (determined in accordance with 525.111(c)(2)) that allows reaching V_2 before reaching a height of 35 feet above the take-off surface; or

(iv) A speed that, if the aeroplane is rotated at its maximum practicable rate, will result in a V_{LOF} or not less than 110 percent of V_{MU} in the all-engines-operating condition and not less than 105 percent of V_{MU} determined at the thrust-to-weight ratio corresponding to the one-engine-inoperative condition.

(2) For any given set of conditions (such as weight, configuration, and temperature), a single value of V_R, obtained in accordance with this paragraph, must be used to show compliance with both the one-engine-inoperative and the all-engines-operating take-off provisions.

(3) It must be shown that the one-engine-inoperative take-off distance, using a rotation speed of 5 knots less than V_R established in accordance with subparagraphs (1) and (2) of this paragraph, does not exceed the corresponding one-engine-inoperative take-off distance using the established V_R. The take-off distances must be determined in accordance with 525.113(a)(1).

(4) Reasonably expected variations in service from the established take-off procedures for the operation of the aeroplane (such as over-rotation of the aeroplane and out-of-trim conditions) may not result in unsafe flight characteristics or in marked increases in the scheduled take-off distances established in accordance with 525.113(a).

(f) V_{LOF} is the calibrated airspeed at which the aeroplane first becomes airborne.

(g) V_{FTO}, in terms of calibrated airspeed, shall be selected by the applicant to provide at least the gradient of climb required by 525.121*(c)*, but shall not be less than
(amended 2008/10/30)

(1) 1.18 V_{SR}; and

(2) A speed that provides the manoeurving capability specified in 525.143(h).
(amended 2008/10/30)

(h) In determining the take-off speeds V_1, V_R and V_2 for flight in icing conditions, the values of V_{MCG}, V_{MC} and V_{MU} determined for non-icing conditions may be used.
(amended 2008/10/30)

(Change 525-8)

525.109 *Accelerate-Stop Distance*

(a) The accelerate-stop distance on a dry runway is the greater of the following distances:

(1) The sum of the distances necessary to:

(i) Accelerate the aeroplane from a standing start with all engines operating to V_{EF} for take-off from a dry runway;

(ii) Allow the aeroplane to accelerate from V_{EF} to the highest speed reached during the rejected take-off, assuming the critical engine fails at V_{EF}; and the pilot takes the first action to reject the take-off at the V_1 for take-off from a dry runway; and

(iii) Come to a full stop on a dry runway from the speed reached as prescribed in paragraph (a)(1)(ii) of this section; plus

(iv) A distance equivalent to 2 seconds at the V_1 for take-off from a dry runway.

(2) The sum of the distances necessary to:

(i) Accelerate the aeroplane from a standing start with all engines operating to the highest speed reached during the rejected take-off, assuming the pilot takes the first action to reject the take-off at the V_1 for take-off from a dry runway; and

(ii) With all engines still operating, come to a full stop on dry runway from the speed reached as prescribed in paragraph (a)(2)(i) of this section; plus

(iii) A distance equivalent to 2 seconds at the V_1 for take-off from a dry runway.

(b) The accelerate-stop distance on a wet runway is the greater of the following distances:

(1) The accelerate-stop distance on a dry runway determined in accordance with paragraph (a) of this section; or

(2) The accelerate-stop distance determined in accordance with paragraph (a) of this section, except that the runway is wet and the corresponding wet runway values of V_{EF} and V_1 are used. In determining the wet runway accelerate-stop distance the stopping force from the wheel brakes may never exceed:

(i) The wheel brakes stopping force determined in meeting the requirements of 525.101(i) and paragraph (a) of this section; and

(ii) The force resulting from the wet runway braking coefficient of friction determined in accordance with paragraphs (c) or (d) of this section, as applicable, taking into account the distribution of the normal load between braked and unbraked wheels at the most adverse centre-of-gravity position approved for take-off.

(c) The wet runway braking coefficient of friction for a smooth wet runway is defined as a curve of friction coefficient versus ground speed and must be computed as follows:

(1) The maximum tire-to-ground wet runway braking coefficient of friction is defined as:

Tire Pressure (psi)	Maximum Braking Coefficient (tire-to-ground)
50	$\mu_{t/g_{MAX}} = -0.0350\left(\frac{V}{100}\right)^3 + 0.306\left(\frac{V}{100}\right)^2 - 0.851\left(\frac{V}{100}\right) + 0.883$
100	$\mu_{t/g_{MAX}} = -0.0437\left(\frac{V}{100}\right)^3 + 0.320\left(\frac{V}{100}\right)^2 - 0.805\left(\frac{V}{100}\right) + 0.804$
200	$\mu_{t/g_{MAX}} = -0.0331\left(\frac{V}{100}\right)^3 + 0.252\left(\frac{V}{100}\right)^2 - 0.658\left(\frac{V}{100}\right) + 0.692$
300	$\mu_{t/g_{MAX}} = -0.0401\left(\frac{V}{100}\right)^3 + 0.263\left(\frac{V}{100}\right)^2 - 0.611\left(\frac{V}{100}\right) + 0.614$

Where:

Tire Pressure = maximum aeroplane operating tire pressure (psi);

($\mu_{t/gMAX}$ maximum tire-to-ground braking coefficient;

V = aeroplane true ground speed (knots); and

Linear interpolation may be used for tire pressures other than those listed.

(2) The maximum tire-to-ground wet runway braking coefficient of friction must be adjusted to take into account the efficiency of the anti-skid system on a wet runway. Anti-skid system operation must be demonstrated by flight testing on a smooth wet runway, and its efficiency must be determined. Unless a specific anti-skid system efficiency is determined from a quantitative analysis of the flight testing on a smooth wet runway, the maximum tire-to-ground wet runway braking coefficient of friction determined in paragraph (c)(1) of this section must be multiplied by the efficiency value associated with the type of anti-skid system installed on the aeroplane:

Type of anti-skid system	Efficiency value
On-Off	0.30
Quasi-Modulating	0.50
Fully Modulating	0.80

(d) At the option of the applicant, a higher wet runway braking coefficient of friction may be used for runway surfaces that have been grooved or treated with a porous friction course

material. For grooved and porous friction course runways, the wet runway braking coefficient of friction is defined as either:

(1) 70 percent of the dry runway braking coefficient of friction used to determine the dry runway accelerate-stop distance; or

(2) The wet runway braking coefficient defined in paragraph (c) of this section, except that a specific anti-skid system efficiency, if determined, is appropriate for a grooved or porous friction course wet runway, and the maximum tire-to-ground wet runway braking coefficient of friction is defined as:

Tire Pressure (psi)	Maximum Braking Coefficient (tire-to-ground)
50	$\mu_{t/gMAX} = 0.1470\left(\frac{V}{100}\right)^5 - 1.050\left(\frac{V}{100}\right)^4 + 2.673\left(\frac{V}{100}\right)^3 - 2.683\left(\frac{V}{100}\right)^2 + 0.403\left(\frac{V}{100}\right) + 0.859$
100	$\mu_{t/gMAX} = 0.1106\left(\frac{V}{100}\right)^5 - 0.813\left(\frac{V}{100}\right)^4 + 2.130\left(\frac{V}{100}\right)^3 - 2.200\left(\frac{V}{100}\right)^2 + 0.317\left(\frac{V}{100}\right) + 0.807$
200	$\mu_{t/gMAX} = 0.0498\left(\frac{V}{100}\right)^5 - 0.398\left(\frac{V}{100}\right)^4 + 1.140\left(\frac{V}{100}\right)^3 - 1.285\left(\frac{V}{100}\right)^2 + 0.140\left(\frac{V}{100}\right) + 0.701$
300	$\mu_{t/gMAX} = 0.0314\left(\frac{V}{100}\right)^5 - 0.247\left(\frac{V}{100}\right)^4 + 0.703\left(\frac{V}{100}\right)^3 - 0.779\left(\frac{V}{100}\right)^2 - 0.00954\left(\frac{V}{100}\right) + 0.614$

Where:

Tire Pressure = maximum aeroplane operating tire pressure (psi);

($\mu_{t/gMAX}$ maximum tire-to-ground braking coefficient;

V = aeroplane true ground speed (knots); and

Linear interpolation may be used for tire pressures other than those listed.

(e) Except as provided in paragraph *(f)*(1) of this section, means other than wheel brakes may be used to determine the accelerate-stop distance if that means:

(1) Is safe and reliable;

(2) Is used so that consistent results can be expected under normal operating conditions; and

(3) Is such that exceptional skill is not required to control the aeroplane.

(f) The effects of available reverse thrust:

(1) Shall not be included as an additional means of deceleration when determining the accelerate-stop distance on a dry runway; and

(2) May be included as an additional means of deceleration using recommended reverse thrust procedures when determining the accelerate-stop distance on a wet runway, provided the requirements of paragraph (e) of this section are met.

(g) The landing gear must remain extended throughout the accelerate-stop distance.

(h) If the accelerate-stop distance includes a stopway with surface characteristics substantially different from those of the runway, the take-off data must include operational

correction factors for the accelerate-stop distance. The correction factors must account for the particular surface characteristics of the stopway and the variations in these characteristics with seasonal weather conditions (such as temperature, rain, snow, and ice) within the established operational limits.

(i) A flight test demonstration of the maximum brake kinetic energy accelerate-stop distance must be conducted with not more than 10 percent of the allowable brake wear range remaining on each of the aeroplane wheel brakes.

(Change 525-8)

525.111 *Take-off Path*

(a) The take-off path extends from a standing start to a point in the take-off at which the aeroplane is 1,500 feet above the take-off surface, or at which the transition from the take-off to the en route configuration is completed and V_{FTO} is reached, whichever point is higher. In addition:
(amended 2003/11/10)

(1) The take-off path shall be based on the procedures prescribed in 525.101(f);
(amended 2003/11/10)

(2) The aeroplane shall be accelerated on the ground to V_{EF}, at which point the critical engine shall be made inoperative and remain inoperative for the rest of the take-off; and
(amended 2003/11/10)

(3) After reaching V_{EF}, the aeroplane shall be accelerated to V_2.
(amended 2003/11/10)

(b) During the acceleration to speed V_2, the nose gear may be raised off the ground at a speed not less than V_R. However, landing gear retraction shall not begin until the aeroplane is airborne.
(amended 2005/06/03)

(c) During the take-off path determination in accordance with paragraphs *(a)* and *(b)* of this section:

(1) The slope of the airborne part of the take-off path shall be positive at each point;
(amended 2005/06/03)

(2) The aeroplane shall reach V_2 before it is 35 feet above the take-off surface and shall continue at a speed as close as practical to, but not less than V_2, until it is 400 feet above the take-off surface;
(amended 2005/06/03)

(3) At each point along the take-off path, starting at the point at which the aeroplane reaches 400 feet above the take-off surface, the available gradient of climb shall not be less than:
(amended 2005/06/03)

(i) 1.2 percent for two-engine aeroplanes;

(ii) 1.5 percent for three-engine aeroplanes; and

(iii) 1.7 percent for four-engine aeroplanes; and

(4) The aeroplane configuration shall not be changed, except for landing gear retraction and automatic propeller feathering, and no change in power or thrust that requires action by the pilot shall be made, until the aeroplane is 400 feet above the take-off surface; and
(amended 2008/10/30)

(5) If 525.105(a)(2) requires the take-off path to be determined for flight in icing conditions, the airborne part of the take-off shall be based on the aeroplane drag:
(amended 2008/10/30)

(i) With the take-off ice accretion defined in Appendix C, from a height of 35 feet above the take-off surface up to the point where the aeroplane is 400 feet above the take-off surface; and
(amended 2008/10/30)

(ii) With the final take-off ice accretion defined in Appendix C, from the point where the aeroplane is 400 feet above the take-off surface to the end of the take-off path.
(amended 2008/10/30)

(d) The take-off path shall be determined by a continuous demonstrated take-off or by synthesis from segments. If the take-off path is determined by the segmental method:
(amended 2005/06/03)

(1) The segments shall be clearly defined and shall be related to the distinct changes in the configuration, power or thrust, and speed;
(amended 2005/06/03)

(2) The weight of the aeroplane, the configuration, and the power or thrust shall be constant throughout each segment and shall correspond to the most critical condition prevailing in the segment;
(amended 2005/06/03)

(3) The flight path shall be based on the aeroplane's performance without ground effect; and
(amended 2005/06/03)

(4) The take-off path data shall be checked by continuous demonstrated take-offs up to the point at which the aeroplane is out of ground effect and its speed is stabilised, to ensure that the path is conservative relative to the continuous path. The aeroplane is considered to be out of the ground effect when it reaches a height equal to its wing span.
(amended 2005/06/03)

(e) For aeroplanes equipped with standby power rocket engines, the take-off path may be determined in accordance with Part II of Appendix E.

(Change 525-3 (91-11-01))

525.113 *Take-off Distance and Take-off Run*

(a) Take-off distance on a dry runway is the greater of:

(1) The horizontal distance along the take-off path from the start of the take-off to the point at which the aeroplane is 35 feet above the take-off surface, determined under 525.111; for a dry runway; or

(2) 115 percent of the horizontal distance along the take-off path, with all engines operating, from the start of the take-off to the point at which the aeroplane is 35 feet above the take-off surface, as determined by a procedure consistent with 525.111.

(b) Take-off distance on a wet runway is the greater of:

(1) The take-off distance on a dry runway determined in accordance with paragraph (a) of this section; or

(2) The horizontal distance along the take-off path from the start of the take-off to the point at which the aeroplane is 15 feet above the take-off surface, achieved in a manner consistent with the achievement of V_2 before reaching 35 feet above the take-off surface, determined under 525.111 for a wet runway.

(c) If the take-off distance does not include a clearway, the take-off run is equal to the take-off distance. If the take-off distance includes a clearway:

(1) The take-off run on a dry runway is the greater of:

(i) The horizontal distance along the take-off path from the start of the take-off to a point equidistant between the point at which V_{LOF} is reached and the point at which the aeroplane is 35 feet above the take-off surface, as determined under 525.111; for a dry runway; or

(ii) 115 percent of the horizontal distance along the take-off path, with all engines operating, from the start of the take-off to a point equidistant between the point at which V_{LOF} is reached and the point at which the aeroplane is 35 feet above the take-off surface, determined by a procedure consistent with 525.111.

(2) The take-off run on a wet runway is the greater of:

(i) The horizontal distance along the take-off path form the start of the take-off to the point at which the aeroplane is 15 feet above the take-off surface, achieved in a manner consistent with the achievement of V_2 before reaching 35 feet above the take-off surface, as determined under 525.111 for a wet runway; or

(ii) 115 percent of the horizontal distance along the take-off flight path, with all engines operating, from the start of the take-off to a point equidistant between the point at which V_{LOF} is reached and the point at which the aeroplane is 35 feet above the take-off surface, determined by a procedure consistent with 525.111.

(Change 525-8)

525.115 *Take-off Flight Path*

(a) The take-off flight path shall be considered to begin 35 feet above the take-off surface at the end of the take-off distance determined in accordance with 525.113*(a)* or *(b)*, as appropriate for the runway surface condition.

(b) The net take-off flight path data must be determined so that they represent the actual take-off flight paths (determined in accordance with 525.111 and with paragraph *(a)* of this section) reduced at each point by a gradient of climb equal to:

(1) 0.8 percent for two-engine aeroplanes;

(2) 0.9 percent for three-engine aeroplanes; and

(3) 1.0 percent for four-engine aeroplanes.

(c) The prescribed reduction in climb gradient may be applied as an equivalent reduction in acceleration along that part of the take-off flight path at which the aeroplane is accelerated in level flight.

(Change 525-8)

525.117 *Climb: General*

Compliance with the requirements of 525.119 and 525.121 must be shown at each weight, altitude, and ambient temperature within the operational limits established for the aeroplane and with the most unfavourable centre of gravity for each configuration.

525.119 *Landing Climb: All-Engines-Operating*

In the landing configuration, the steady gradient of climb shall not be less than 3.2 percent, with the engines at the power or thrust that is available eight seconds after initiation of movement of the power or thrust controls from the minimum flight idle to the go-around power or thrust setting:
(amended 2008/10/30)

(a) In non-icing conditions, with a climb speed of V_{REF} determined in accordance with 525.125(b)(2)(i); and
(amended 2008/10/30)

(b) In icing conditions with the landing ice accretion defined in Appendix C, and with a climb speed of V_{REF} determined in accordance with 525.125(b)(2)(ii).
(amended 2008/10/30)

(Change 525-7 (96-09-30))

525.121 *Climb: One-Engine-Inoperative*

(a) Take-off; landing gear extended. In the critical take-off configuration existing along the flight path (between the points at which the aeroplane reaches V_{LOF} and at which the landing gear is fully retracted) and in the configuration used in 525.111 but without ground effect, the steady gradient of climb must be positive for two-engine aeroplanes, and not less than 0.3 percent for three-engine aeroplanes or 0.5 percent for four-engine aeroplanes, at V_{LOF} and with:

(1) The critical engine inoperative and the remaining engines at the power or thrust available when retraction of the landing gear is begun in accordance with 525.111 unless there is a more critical power operating condition existing later along the flight path but before the point at which the landing gear is fully retracted; and

(2) The weight equal to the weight existing when retraction of the landing gear is begun, determined under 525.111.

(b) Take-off; landing gear retracted. In the take-off configuration existing at the point of the flight path at which the landing gear is fully retracted, and in the configuration used in 525.111 but without ground effect:
(amended 2008/10/30)

(1) the steady gradient of climb shall not be less than 2.4 percent for two-engine aeroplanes, 2.7 percent for three-engine aeroplanes, and 3.0 percent for four-engine aeroplanes, at V_2 with:
(amended 2008/10/30)

(i) The critical engine inoperative, the remaining engines at the take-off power or thrust available at the time the landing gear is fully retracted, as determined under 525.111, unless there is a more critical power operating condition existing later along the flight path but before the point where the aeroplane reaches a height of 400 feet above the take-off surface; and
(amended 2008/10/30)

(ii) The weight equal to the weight existing when the aeroplane's landing gear is fully retracted, as determined under 525.111.
(amended 2008/10/30)

(2) The requirements of paragraph (b)(1) of this section shall be met:
(amended 2008/10/30)

(i) In non-icing conditions; and
(amended 2008/10/30)

(ii) In icing conditions with the take-off ice accretion defined in Appendix C, if in the configuration of 525.121(b) with the take-off ice accretion:
(amended 2008/10/30)

(A) The stall speed at maximum take-off weight exceeds that in non-icing conditions by more than the greater of 3 knots CAS or 3 percent of V_{SR}; or
(amended 2008/10/30)

(B) The degradation of the gradient of climb determined in accordance with 525.121(b) is greater than one-half of the applicable actual-to-net take-off flight path gradient reduction defined in 525.115(b).
(amended 2008/10/30)

(c) Final take-off. In the en route configuration at the end of the take-off path determined in accordance with 525.111:
(amended 2008/10/30)

(1) The steady gradient of climb shall not be less than 1.2 percent for two-engine aeroplanes, 1.5 percent for three-engine aeroplanes, and 1.7 percent for four-engine aeroplanes, at V_{FTO} with:
(amended 2008/10/30)

(i) The critical engine inoperative and the remaining engines at the available maximum continuous power or thrust; and
(amended 2008/10/30)

(ii) The weight equal to the weight existing at the end of the take-off path, determined under 525.111.
(amended 2008/10/30)

(2) The requirements of paragraph (c)(1) of this section shall be met:
(amended 2008/10/30)

(i) In non-icing conditions; and
(amended 2008/10/30)

(ii) In icing conditions with the final take-off ice accretion defined in Appendix C, if in the configuration of 525.121(b) with the take-off ice accretion:
(amended 2008/10/30)

(A) The stall speed at maximum take-off weight exceeds that in non-icing conditions by more than the greater of 3 knots CAS or 3 percent of V_{SR}; or
(amended 2008/10/30)

(B) The degradation of the gradient of climb determined in accordance with 525.121(b) is greater than one-half of the applicable actual-to-net take-off flight path gradient reduction defined in 525.115(b).
(amended 2008/10/30)

(d) Approach. In a configuration corresponding to the normal all-engines-operating procedure in which V_{SR} for this configuration does not exceed 110 percent of the V_{SR} for the related all-engines-operating landing configuration:
(amended 2008/10/30)

(1) The steady gradient of climb shall not be less than 2.1 percent for two-engine aeroplanes, 2.4 percent for three-engine aeroplanes, and 2.7 percent for four-engine aeroplanes, with:
(amended 2008/10/30)

(i) The critical engine inoperative, the remaining engines at the go-around power or thrust setting;
(amended 2008/10/30)

(ii) The maximum landing weight;
(amended 2008/10/30)

(iii) A climb speed established in connection with normal landing procedures, but not exceeding 1.4 V_{SR}; and
(amended 2008/10/30)

(iv) Landing gear retracted.
(amended 2008/10/30)

(2) The requirements of paragraph (d)(1) of this section shall be met:
(amended 2008/10/30)

(i) In non-icing conditions; and
(amended 2008/10/30)

(ii) In icing conditions with the approach ice accretion defined in Appendix C. The climb speed selected for non-icing conditions may be used if the climb speed for icing conditions, computed in accordance with (d)(1)(iii) of this section, does not exceed that for non-icing conditions by more than the greater of 3 knots CAS or 3 percent.
(amended 2008/10/30)

(Change 525-7 (96-09-30))

525.123 *En Route Flight Paths*

(a) For the en route configuration, the flight paths prescribed in paragraphs *(b)* and *(c)* of this section shall be determined at each weight, altitude, and ambient temperature, within the operating limits established for the aeroplane. The variation of weight along the flight path, accounting for the progressive consumption of fuel and oil by the operating engines, may be included in the computation. The flight paths shall be determined at a speed not less than V_{FTO}, with:
(amended 2008/10/30)

(1) The most unfavourable centre of gravity;

(2) The critical engines inoperative;

(3) The remaining engines at the available maximum continuous power or thrust; and

(4) The means for controlling the engine-cooling air supply in the position that provides adequate cooling in the hot-day condition.

(b) The one-engine-inoperative net flight path data shall represent the actual climb performance diminished by a gradient of climb of 1.1 percent for two-engine aeroplanes, 1.4 percent for three-engine aeroplanes, and 1.6 percent for four-engine aeroplanes:
(amended 2008/10/30)

(1) In non-icing conditions; and
(amended 2008/10/30)

(2) In icing conditions with the en route ice accretion as defined in Appendix C, if:
(amended 2008/10/30)

(i) A speed of 1.18 V_{SR} with the en route ice accretion exceeds the en route speed selected for non-icing conditions by more than the greater of 3 knots CAS or 3 percent of V_{SR}; or
(amended 2008/10/30)

(ii) The degradation of the gradient of climb is greater than one-half of the applicable actual-to-net flight path reduction defined in (b) of this section.
(amended 2008/10/30)

(c) For three or four-engine aeroplanes, the two-engine-inoperative net flight path data must represent the actual climb performance diminished by a gradient climb of 0.3 percent for three-engine aeroplanes and 0.5 percent for four-engine aeroplanes.

525.125 *Landing*

(a) The horizontal distance necessary to land and to come to a complete stop (or to a speed of approximately 3 knots for water landings) from a point 50 feet above the landing surface shall be determined (for standard temperatures, at each weight, altitude and wind within the operational limits established by the applicant for the aeroplane):
(amended 2008/10/30)

(1) In non-icing conditions; and
(amended 2008/10/30)

(2) In icing conditions with the landing ice accretion defined in Appendix C if V_{REF} for icing conditions exceeds V_{REF} for non-icing conditions by more than 5 knots CAS at the maximum landing weight.
(amended 2008/10/30)

(b) In determining the distance in subsection (a) of this section:
(amended 2008/10/30)

(1) The aeroplane shall be in the landing configuration.
(amended 2008/10/30)

(2) A stabilized approach, with a calibrated airspeed of not less than V_{REF} shall be maintained down to the 50 foot height.
(amended 2008/10/30)

(i) In non-icing conditions, V_{REF} shall not be less than:
(amended 2008/10/30)

(A) 1.23 V_{SR0};

(B) V_{MCL} established under 525.149(f); and

(C) A speed that provides the manoeuvring capability specified in 525.143(h).

(ii) In icing conditions, V_{REF} shall not be less than:
(amended 2008/10/30)

(A) The speed determined in paragraph (b)(2)(i) of this section;

(B) 1.23 V_{SR0} with the landing ice accretion defined in Appendix C if that speed exceeds V_{REF} for non-icing conditions by more than 5 knots CAS; and

(C) A speed that provides the manoeuvering capability specified in 525.143(h) with the landing ice accretion defined in Appendix C.

(3) Changes in configuration, power or thrust, and speed, shall be made in accordance with the established procedures for service operation.
(amended 2008/10/30)

(4) The landing shall be made without excessive vertical acceleration, tendency to bounce, nose over, ground loop, porpoise, or water loop.
(amended 2008/10/30)

(5) The landing shall not require exceptional piloting skill or alertness.
(amended 2008/10/30)

(c) For landplanes and amphibians, the landing distance on land shall be determined on a level, smooth, dry, hard-surfaced runway. In addition:
(amended 2008/10/30)

(1) The pressures on the wheel braking systems shall not exceed those specified by the brake manufacturer;

(2) The brakes shall not be used so as to cause excessive wear of brakes or tires; and

(3) Means other than wheel brakes shall be used if that means:

(i) Is safe and reliable;

(ii) Is used so that consistent results can be expected in service; and

(iii) Is such that exceptional skill is not required to control the aeroplane.

(d) For seaplanes and amphibians, the landing distance on water shall be determined on smooth water.
(amended 2008/10/30)

(e) For skiplanes, the landing distance on snow shall be determined on smooth, dry snow.
(amended 2008/10/30)

(f) The landing distance data shall include correction factors for not more than 50 percent of the nominal wind components along the landing path opposite to the direction of landing, and not less than 150 percent of the nominal wind components along the landing path in the direction of landing.
(amended 2008/10/30)

(g) If any device is used that depends on the operation of any engine, and if the landing distance would be noticeably increased when landing is made with that engine inoperative, the landing distance shall be determined with that engine inoperative unless the use of compensating means will result in a landing distance not more than that with each engine operating.
(amended 2008/10/30)

(Change 525-2 (89-01-01))
(Change 525-3 (91-11-01))
(Change 525-7 (96-09-30))
(Change 525-8)

Controllability and Manoeuvrability

525.143 *General*

(a) The aeroplane must be safely controllable and manoeuvrable during:

(1) Take-off;

(2) Climb;

(3) Level flight;

(4) Descent; and

(5) Landing.

(b) It must be possible to make a smooth transition from one flight condition to any other flight condition without exceptional piloting skill, alertness, or strength, and without danger of exceeding the aeroplane limit-load factor under an probable operating conditions, including:

(1) The sudden failure of the critical engine;

(2) For aeroplanes with three or more engines, the sudden failure of the second critical engine when the aeroplane is in the en route, approach, or landing configuration and is trimmed with the critical engine inoperative; and

(3) Configuration changes, including deployment or retraction of deceleration devices.

(c) The aeroplane shall be shown to be safely controllable and manoeuvrable with the critical ice accretion appropriate to the phase of flight defined in Appendix C, and with the critical engine inoperative and its propeller (if applicable) in the minimum drag position:
(amended 2008/10/30)

(1) At the minimum V_2 for take-off;
(amended 2008/10/30)

(2) During an approach and go-around; and
(amended 2008/10/30)

(3) During an approach and landing.
(amended 2008/10/30)

(d) The following table prescribes, for conventional wheel type controls, the maximum control forces permitted during the testing required by paragraphs *(a)* through *(c)* of this section:
(amended 2008/10/30)

Force, In Pounds, Applied To The Control Wheel or Rudder Pedals	Pitch	Roll	Yaw
For short term application for pitch and roll control - two hands available for control	75	50	---
For short term application for pitch and roll control - one hand available for control	50	25	---
For short term application for yaw control	---	---	150
For long term application	10	5	20
(amended 2008/10/30)			

(e) Approved operating procedures or conventional operating practices shall be followed when demonstrating compliance with the control force limitations for short term application that are prescribed in paragraph *(d)* of this section. The aeroplane shall be in trim, or as near to being in trim as practical, in the preceding steady flight condition. For the take-off condition,

the aeroplane shall be trimmed according to the approved operating procedures.
(amended 2008/10/30)

(f) When demonstrating compliance with the control force limitations for long term application that are prescribed in paragraph *(d)* of this section, the aeroplane shall be in trim, or as near to being in trim as practical.
(amended 2008/10/30)

(g) When manoeuvring at a constant airspeed or Mach number (up to V_{FC}/M_{FC}), the stick forces and the gradient of the stick force versus manoeuvring load factor shall lie within satisfactory limits. The stick forces shall not be so great as to make excessive demands on the pilot's strength when manoeuvring the aeroplane, and shall not be so low that the aeroplane can easily be overstressed inadvertently. Changes of gradient that occur with changes of load factor shall not cause undue difficulty in maintaining control of the aeroplane, and local gradients must not be so low as to result in a danger of overcontrolling.
(amended 2008/10/30)

(h) The manoeuvring capabilities in a constant speed coordinated turn at forward centre of gravity, as specified in the following table, shall be free of stall warning or other characteristics that might interfere with normal manoeuvring:
(amended 2003/11/10)

Configuration	Speed	Manoeuvring bank angle in a coordinated turn	Thrust power setting
Take-off	V_2	30°	Asymmetric WAT-Limited.[1]
Take-off	[2]V_2 +XX	40°	All-engines-operating climb.[3]
En route	V_{FTO}	40°	Asymmetric WAT-Limited.[1]
Landing	V_{REF}	40°	Symmetric for -3° flight path angle.

[1] A combination of weight, altitude, and temperature (WAT) such that the thrust or power setting produces the minimum climb gradient specified in 525.121 for the flight condition.

[2] Airspeed approved for all-engines-operating initial climb.

[3] That thrust or power setting which, in the event of failure of the critical engine and without any flight crew action to adjust the thrust or power of the remaining engines, would result in the thrust or power specified for the take-off condition at V_2, or any lesser thrust or power setting that is used for all-engines-operating initial climb procedures.

(amended 2008/10/30)

(i) When demonstrating compliance with 525.143 in icing conditions:
(amended 2008/10/30)

(1) Controllability shall be demonstrated with the ice accretion defined in Appendix C that is most critical for the particular flight phase;
(amended 2008/10/30)

(2) It shall be shown that a push force is required throughout a pushover manoeuvre down to a zero g load factor, or the lowest load factor obtainable if limited by elevator power or

other design characteristic of the flight control system. It shall be possible to promptly recover from the manoeuvre without exceeding a pull control force of 50 pounds; and (amended 2008/10/30)

(3) Any changes in force that the pilot shall apply to the pitch control to maintain speed with increasing sideslip angle shall be steadily increasing with no force reversals, unless the change in control force is gradual and easily controllable by the pilot without using exceptional piloting skill, alertness, or strength.
(amended 2008/10/30)

(j) For flight in icing conditions before the ice protection system has been activated and is performing its intended function, the following requirements apply:
(amended 2008/10/30)

(1) If activating the ice protection system depends on the pilot seeing a specified ice accretion on a reference surface (not just the first indication of icing), the requirements of 525.143 apply with the ice accretion defined in Appendix C, Part II(e).
(amended 2008/10/30)

(2) For other means of activating the ice protection system, it shall be demonstrated in flight with the ice accretion defined in Appendix C, Part II(e) that:
(amended 2008/10/30)

(i) The aeroplane is controllable in a pull-up manoeuvre up to 1.5 g load factor; and
(amended 2008/10/30)

(ii) There is no pitch control force reversal during a pushover manoeuvre down to 0.5 g load factor.
(amended 2008/10/30)

(Change 525-2 (89-01-01))
(Change 525-7 (96-09-30))

525.145 *Longitudinal Control*

(a) It shall be possible, at any point between the trim speed prescribed in 525.103*(b)*(6) and stall identification (as defined in 525.201*(d)*), to pitch the nose downward so that the acceleration to this selected trim speed is prompt with:
(amended 2003/11/10)

(1) The aeroplane trimmed at the trim speed prescribed in 525.103 (b)(6);
(amended 2003/11/10)

(2) The landing gear extended;

(3) The wing flaps (i) retracted and (ii) extended; and

(4) Power (i) off and (ii) at maximum continuous power on the engines.

(b) With the landing gear extended, no change in trim control, or exertion of more than 50 pounds control force (representative of the maximum short term force that can be applied readily by one hand) may be required for the following manoeuvres:

(1) With power off, flaps retracted, and the aeroplane trimmed at 1.3 V_{SR1}, extend the flaps as rapidly as possible while maintaining the airspeed at approximately 30 percent above the reference stall speed existing at each instant throughout the manoeuvre.
(amended 2003/11/10)

(2) Repeat paragraph (b)(1) except initially extend the flaps and then retract them as rapidly as possible.
(amended 2003/11/10)

(3) Repeat paragraph (b)(2), except at the go-around power or thrust setting.

(4) With power off, flaps retracted, and the aeroplane trimmed at 1.3 V_{SR1}, rapidly set go-around power or thrust while maintaining the same airspeed.
(amended 2003/11/10)

(5) Repeat paragraph (b)(4) except with flaps extended.
(amended 2003/11/10)

(6) With power off, flaps extended, and the aeroplane trimmed at 1.3 V_{SR1}, obtain and maintain airspeeds between V_{SW} and either 1.6 V_{SR1}, or V_{FE}, whichever is lower.
(amended 2003/11/10)

(c) It shall be possible, without exceptional piloting skill, to prevent loss of altitude when complete retraction of the high-lift devices from any position is begun during steady, straight, level flight at 1.08 V_{SR1} for propeller powered aeroplanes, or 1.13 V_{SR1} for turbojet powered aeroplanes, with:
(amended 2003/11/10)

(1) Simultaneous movement of the power or thrust controls to the go-around power or thrust setting;

(2) The landing gear extended; and

(3) The critical combinations of landing weights and altitudes.

(d) If gated high-lift device control positions are provided, paragraph *(c)* of this section applies to retractions of the high-lift devices from any position from the maximum landing position to the first gated position, between gated positions, and from the last gated position to the fully retracted position. The requirements of paragraph *(c)* of this section also apply to retractions from each approved landing position to the control position(s) associated with the high-lift device configuration(s) used to establish the go-around procedure(s) from that landing position. In addition, the first gated control position from the maximum landing position must correspond with a configuration of the high-lift devices used to establish a go-around procedure from a landing configuration. Each gated control position must require a separate and distinct motion of the control to pass through the gated position and must have features to prevent inadvertent movement of the control through the gated position. It must only be possible to make this separate and distinct motion once the control has reached the gated position.

(Change 525-2 (89-01-01))
(Change 525-3 (91-11-01))

(Change 525-7 (96-09-30))
(Change 525-8)

525.147 *Directional and Lateral Control*

(a) Directional Control, General. It shall be possible, with the wings level, to yaw into the operative engine and to safely make a reasonably sudden change in heading of up to 15 degrees in the direction of the critical inoperative engine. This shall be demonstrated at 1.3 V_{SR1} for heading changes up to 15° (except that the heading change at which the rudder pedal force is 150 pounds need not be exceeded), and with:
(amended 2003/11/10)

(1) The critical engine inoperative and its propeller in the minimum drag position;

(2) The power required for level flight at 1.3 V_{SR1}, but not more than maximum continuous power;
(amended 2003/11/10)

(3) The most unfavourable centre of gravity;

(4) Landing gear retracted;

(5) Flaps in the approach position; and

(6) Maximum landing weight.

(b) Directional control; aeroplanes with four or more engines. Aeroplanes with four or more engines shall meet the requirements of paragraph *(a)* of this section except that:
(amended 2003/11/10)

(1) The two critical engines shall be inoperative with their propellers (if applicable) in the minimum drag position;
(amended 2003/11/10)

(2) (Reserved);

(3) The flaps shall be in the most favourable climb position.
(amended 2003/11/10)

(c) Lateral control; general It shall be possible to make 20° banked turns, with and against the inoperative engine, from steady flight at a speed equal to 1.3 V_{SR1} with:
(amended 2003/11/10)

(1) The critical engine inoperative and its propeller (if applicable) in the minimum drag position;

(2) The remaining engines at maximum continuous power;

(3) The most unfavourable centre of gravity;

(4) Landing gear (i) retracted and (ii) extended;

(5) Flaps in the most favourable climb position; and

(6) Maximum take-off weight.

(d) Lateral control; roll capability. With the critical engine inoperative, roll response shall allow normal manoeuvres. Lateral control shall be sufficient, at the speeds likely to be used with one engine inoperative, to provide a roll rate necessary for safety without excessive control forces or travel.
(amended 2005/06/03)

(e) Lateral control; aeroplanes with four or more engines. Aeroplanes with four or more engines shall be able to make 20° banked turns, with and against the inoperative engines, from steady flight at a speed equal to 1.3 V_{SR1}, with maximum continuous power, and with the aeroplane in the configuration prescribed by paragraph *(b)* of this section.
(amended 2003/11/10)

(f) Lateral control; all engines operating. With the engines operating, roll response shall allow normal manoeuvres (such as recovery from upsets produced by gusts and the initiation of evasive manoeuvres). There shall be enough excess lateral control in sideslips (up to sideslip angles that might be required in normal operation), to allow a limited amount of manoeuvring and to correct for gusts. Lateral control shall be enough at any speed up to V_{FC}/M_{FC} to provide a peak roll rate necessary for safety, without excess control forces or travel.
(amended 2003/11/10)

(Change 525-3 (91-11-01))

525.149 *Minimum Control Speed*

(a) In establishing the minimum control speeds required by this section, the method used to simulate critical engine failure must represent the most critical mode of powerplant failure with respect to controllability expected in service.

(b) V_{MC} is the calibrated air-speed, at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane with that engine still inoperative and maintain straight flight with an angle or bank of not more than 5 degrees.

(c) V_{MC} may not exceed 1.13 V_{SR} with:
(amended 2003/11/10)

(1) Maximum available take-off power or thrust on the engines;

(2) The most unfavourable centre of gravity;

(3) The aeroplane trimmed for take-off;

(4) The maximum sea level take-off weight (or any lesser weight necessary to show V_{MC});

(5) The aeroplane in the most critical take-off configuration existing along the flight path after the aeroplane becomes airborne, except with the landing gear retracted; and

(6) The aeroplane airborne and the ground effect negligible; and

(7) If applicable, the propeller of the inoperative engine:

(i) Windmilling;

(ii) In the most probable position for the specific design of the specific design of the propeller control; or

(iii) Feathered, if the aeroplane has an automatic feathering device acceptable for showing compliance with the climb requirements of 525.121.

(d) The rudder forces required to maintain control at V_{MC} may not exceed 150 pounds nor may it be necessary to reduce power or thrust of the operative engines. During recovery, the aeroplane may not assume any dangerous attitude or require exceptional piloting skill, alertness, or strength to prevent a heading change of more than 20 degrees.

(e) V_{MCG}, the minimum control speed on the ground, is the calibrated airspeed during the take-off run at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane using rudder control alone (without the use of nose-wheel steering), as limited by 150 pounds of force, and the lateral control to the extent of keeping the wings level to enable the take-off to be safely continued using normal piloting skill. In the determination of V_{MCG}, assuming that the path of the aeroplane accelerating with all engines operating is along the centreline of the runway, its path from the point at which the critical engine is made inoperative to the point at which recovery to a direction parallel to the centreline is completed may not deviate more than 30 feet laterally from the centreline at any point. V_{MCG} must be established with:

(1) The aeroplane in each take-off configuration or, at the option of the applicant, in the most critical take-off configuration;

(2) Maximum available take-off power or thrust on the operating engines;

(3) The most unfavourable centre of gravity;

(4) The aeroplane trimmed for take-off; and

(5) The most unfavourable weight in the range of take-off weights.

(f) V_{MCL}, the minimum control speed during approach and landing with all engines operating, is the calibrated airspeed at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane with that engine still inoperative, and maintain straight flight with an angle of bank of not more than 5 degrees. V_{MCL} must be established with:

(1) The aeroplane in the most critical configuration (or, at the option of the applicant, each configuration) for approach and landing with all engines operating;

(2) The most unfavourable centre of gravity;

(3) The aeroplane trimmed for approach with all engines operating;

(4) The most favourable weight, or, at the option of the applicant, as a function of weight;

(5) For propeller aeroplanes, the propeller of the inoperative engine in the position it achieves without pilot action, assuming the engine fails while at the power or thrust necessary to maintain a three degree approach path angle; and

(6) Go-around power or thrust setting on the operating engine(s).

(g) For aeroplanes with three or more engines V_{MCL-2} the minimum control speed during approach and landing with one critical engine inoperative, is the calibrated airspeed at which, when a second critical engine is suddenly made inoperative, it is possible to maintain control

of the aeroplane with both engines still inoperative and maintain straight flight with an angle of bank of not more than 5 degrees. V_{MCL-2} must be established with:

(1) The aeroplane in the most critical configuration (or, at the option of the applicant, each configuration) for approach and landing with one critical engine inoperative;

(2) The most unfavourable centre of gravity;

(3) The aeroplane trimmed for approach with one critical engine inoperative;

(4) The most unfavourable weight, or, at the option of the applicant, as a function of weight;

(5) For propeller aeroplanes, the propeller of the more critical inoperative engine in the position it achieves without pilot action, assuming the engine fails while at the power or thrust necessary to maintain a three degree approach path angle, and the propeller of the other inoperative engine feathered;

(6) The power or thrust on the operating engine(s) necessary to maintain an approach path angle of three degrees when one critical engine is inoperative; and

(7) The power or thrust on the operating engine(s) rapidly changed, immediately after the second critical engine is made inoperative, from the power or thrust prescribed in paragraph (g) (6) of this section to:

(i) Minimum power or thrust; and

(ii) Go-around power or thrust setting.

(h) In demonstration of V_{MCL} and V_{MCL-2}:

(1) The rudder force may not exceed 150 pounds;

(2) The aeroplane may not exhibit hazardous flight characteristics or require exceptional piloting skill, alertness, or strength;

(3) Lateral control must be sufficient to roll the aeroplane, from an initial condition of steady flight, through an angle of 20 degrees in the direction necessary to initiate a turn away from the inoperative engine(s), in not more than 5 seconds; and

(4) For propeller aeroplanes, hazardous flight characteristics must not be exhibited due to any propeller position achieved when the engine fails or during any likely subsequent movements of the engine or propeller controls.

(Change 525-3 (91-11-01))
(Change 525-7 (96-09-30))

Trim

525.161 *Trim*

(a) General. Each aeroplane shall meet the trim requirements of this section after being trimmed, and without further pressure upon, or movement of, either the primary controls or their corresponding trim controls by the pilot or the automatic pilot.
(amended 2003/11/10)

(b) Lateral and directional trim. The aeroplane shall maintain lateral and directional trim with the most adverse lateral displacement of the centre of gravity within the relevant operating limitations, during normally expected conditions of operation (including operation at any speed from 1.3 V_{SR1} to V_{MO}/M_{MO}).
(amended 2003/11/10)

(c) Longitudinal trim. The aeroplane shall maintain longitudinal trim during:

(1) A climb with maximum continuous power at a speed not more than 1.3 V_{SR1}, with the landing gear retracted, and the flaps:
(amended 2003/11/10)

(i) retracted; and

(ii) in the take-off position;

(2) Either a glide with power off at a speed not more than 1.3 V_{SR1}, or an approach within the normal range of approach speeds appropriate to the weight and configuration with power settings corresponding to a 3 degree glidepath, whichever is the most severe, with the landing gear extended, the wing flaps (i) retracted and (ii) extended, and with the most unfavourable combination of centre of gravity position and weight approved for landing; and
(amended 2005/06/03)

(3) Level flight at any speed from 1.3 V_{SR1} to V_{MO}/M_{MO}, with the landing gear and flaps retracted, and from 1.3 V_{SR1} to V_{LE} with the landing gear extended.
(amended 2003/11/10)

(d) Longitudinal, directional, and lateral trim. The aeroplane shall maintain longitudinal, directional, and lateral trim (and for lateral trim, the angle of bank shall not exceed five degrees) at 1.3 V_{SR1} during climbing flight with:
(amended 2005/06/03)

(1) The critical engine inoperative;

(2) The remaining engines at maximum continuous power; and

(3) The landing gear and flaps retracted.

(e) Aeroplanes with four or more engines. Each aeroplane with four or more engines shall maintain trim in rectilinear flight with the most unfavourable centre of gravity and at the climb speed, configuration, and power required by 525.123*(a)* for the purpose of establishing the en route flight paths with two engines inoperative.
(amended 2005/06/03)

Stability

525.171 *General*

The aeroplane must be longitudinally, directionally, and laterally stable in accordance with the provisions of 525.173 through 525.177. In addition, suitable stability and control feel (static stability) is required in any condition normally encountered in service, if flight tests show it is necessary for safe operation.

525.173 *Static Longitudinal Stability*

Under the conditions specified in 525.175, the characteristics of the elevator control forces (including friction) must be as follows:

(a) A pull must be required to obtain and maintain speeds below the specified trim speed, and a push must be required to obtain and maintain speeds above the specified trim speed. This must be shown at any speed that can be obtained except speeds higher than the landing gear or wing flap operating limit speeds or V_{FC}/M_{FC}, whichever is appropriate, or lower than the minimum speed for steady unstalled flight.

(b) The airspeed must return to within 10 percent of the original trim speed for the climb, approach, and landing conditions specified in 525.175*(a)*, *(c)*, and *(d)*, and must return to within 7.5 percent of the original trim speed for the cruising condition specified in 525.175*(b)*, when the control force is slowly released from any speed within the range specified in paragraph *(a)* of this section.

(c) The average gradient of the stable slope of the stick force versus speed curve may not be less than 1 pound for each 6 knots.

(d) Within the free return speed range specified in paragraph *(b)* of this section, it is permissible for the aeroplane, without control forces, to stabilise on speeds above or below the desired trim speeds if exceptional attention on the part of the pilot is not required to return to and maintain the desired trim speed and altitude.

525.175 *Demonstration of Static Longitudinal Stability*

Static longitudinal stability shall be demonstrated as follows:
(amended 2003/11/10)

(a) Climb. The stick force curve shall have a stable slope at speeds between 85 and 115 percent of the speed at which the aeroplane:
(amended 2003/11/10)

(1) Is trimmed with:

(i) Wing flaps retracted;

(ii) Landing gear retracted;

(iii) Maximum take-off weight; and

(iv) 75 percent of maximum continuous power for reciprocating engines or the maximum power or thrust selected by the applicant as an operating limitation for use during climb for turbine engines; and

(2) Is trimmed at the speed for best rate-of-climb except that the speed need not be less than 1.3 V_{SR1}.
(amended 2003/11/10)

(b) Cruise. Static longitudinal stability shall be demonstrated in the cruise condition as follows:
(amended 2003/11/10)

(1) With the landing gear retracted at high speed, the stick force curve shall have a stable slope at all speeds within a range which is the greater of 15 percent of the trim speed plus the resulting free return speed range, or 50 knots plus the resulting free return speed range, above and below the trim speed (except that the speed range need not include speeds less than 1.3 V_{SR1}, nor speeds greater than V_{FC}/M_{FC}, nor speeds that require a stick force of more than 50 pounds), with:
(amended 2003/11/10)

(i) Wing flaps retracted;

(ii) The centre of gravity in the most adverse position (see 525.27);

(iii) The most critical weight between the maximum take-off and maximum landing weights.

(iv) 75 percent of maximum continuous power for reciprocating engines or, for turbine engines, the maximum cruising power selected by the applicant as an operating limitation (see 525.1521), except that the power need not exceed that required at V_{MO}/M_{MO}; and

(v) The aeroplane trimmed for level flight with the power required in (b)(1)(iv) above.
(amended 2005/06/03)

(2) With the landing gear retracted at low speed, the stick force curve shall have a stable slope at all speeds within a range which is the greater of 15 percent of the trim speed plus the resulting free return speed range, or 50 knots plus the resulting free return speed range, above and below the trim speed (except that the speed range need not include speeds less than 1.3 V_{SR1}, nor speeds greater than the minimum speed of the applicable speed range prescribed in (b)(1), nor speeds that require a stick force of more than 50 pounds), with:
(amended 2005/06/03)

(i) Wing flaps, centre of gravity position, and weight as specified in (b)(1) of this section;
(amended 2005/06/03)

(ii) Power required for level flight at a speed equal to:

$\frac{V_{MO} + 1.3\ V_{SR1}}{2}$ and
(amended 2003/11/10)

(iii) The aeroplane trimmed for level flight with the power required in (b)(2)(ii) above.
(amended 2005/06/03)

(3) With the landing gear extended, the stick force curve shall have a stable slope at all speeds within a range which is the greater of 15 percent of the trim speed plus the resulting free return speed range, or 50 knots plus the resulting free return speed range, above and below the trim speed (except that the speed range need not include speeds less than 1.3 V_{SR1}, nor speeds greater than V_{LE}, nor speeds that require a stick force of more than 50 pounds), with:

(i) Wing flap, centre of gravity position, and weight as specified in (b)(1) above; (amended 2005/06/03)

(ii) 75 percent of maximum continuous power for reciprocating engines or, for turbine engines, the maximum cruising power selected by the applicant as an operating limitation, except that the power need not exceed that required for level flight at V_{LE}; and

(iii) The aircraft trimmed for level flight with the power required in (b)(3)(ii) above.
(amended 2005/06/03)

(c) Approach. The stick force curve shall have a stable slope at speeds between V_{SW} and 1.7 V_{SR1}, with:
(amended 2003/11/10)

(1) Wing flaps in the approach position;

(2) Landing gear retracted;

(3) Maximum landing weight; and

(4) The aeroplane trimmed at 1.3 V_{SR1} with enough power to maintain level flight at this speed.
(amended 2003/11/10)

(d) Landing. The stick force curve shall have a stable slope and the stick force shall not exceed 80 pounds, at speeds between V_{SW} and 1.7 V_{SR0} with:
(amended 2005/06/03)

(1) Wing flaps in the landing position;

(2) Landing gear extended;

(3) Maximum landing weight;

(4) The aeroplane trimmed at 1.3 V_{SR0} with:
(amended 2005/06/03)

(i) Power or thrust off; and

(ii) Power or thrust for level flight.

(5) The aeroplane trimmed at 1.3 V_{SR0} with power or thrust off.
(amended 2003/11/10)

(Change 525-3 (91-11-01))

525.177 *Static Lateral-Directional Stability*

(a) (Reserved)

(b) (Reserved)

(c) In straight, steady sideslips the aileron and rudder control movements and forces shall be substantially proportional to the angle of sideslip in a stable sense; and the factor of proportionality shall lie between limits found necessary for safe operation throughout the

range of sideslip angles appropriate to the operation of the aeroplane. At greater angles, up to the angle at which full rudder control is used or a rudder pedal force of 180 pounds is obtained, the rudder pedal forces may not reverse; and increased rudder deflection shall be needed to produce increased angles of sideslip. Compliance with this paragraph shall be demonstrated for all landing gear and flap positions and symmetrical power conditions at speeds from 1.13 V_{SR1} to V_{FE}, V_{LE}, or V_{FC}/M_{FC}, as appropriate.
(amended 2003/11/10)

(d) The rudder gradients must meet the requirements of paragraph *(c)* at speeds between V_{MO}/M_{MO} and V_{FC}/M_{FC} except that the dihedral effect (aileron deflection opposite the corresponding rudder input) may be negative provided the divergence is gradual, easily recognised, and easily controlled by the pilot.

(Change 525-3 (91-11-01))

525.181 *Dynamic Stability*

(a) Any short period oscillation, not including combined lateral directional oscillations, occurring between 1.13 V_{SR} and maximum allowable speed appropriate to the configuration of the aeroplane shall be heavily damped with the primary controls:
(amended 2003/11/10)

(1) Free; and

(2) In a fixed position.

(b) Any combined lateral-directional oscillations (“Dutch roll”) occurring between 1.13 V_{SR} and maximum allowable speed appropriate to the configuration of the aeroplane shall be positively damped with controls free, and shall be controllable with normal use of the primary controls without requiring exceptional pilot skill.
(amended 2003/11/10)

(Change 525-3 (91-11-01))

Stalls

525.201 *Stall Demonstration*

(a) Stalls shall be demonstrated in straight flight and in 30 degree banked turns with:
(amended 2003/11/10)

(1) Power off; and

(2) The power necessary to maintain level flight at 1.5 V_{SR1} (where V_{SR1} corresponds to the reference stall speed at maximum landing weight with flaps in the approach position and the landing gear retracted.
(amended 2003/11/10)

(b) In each condition required by paragraph *(a)* of this section, it shall be possible to meet the applicable requirements of 525.203 with:
(amended 2003/11/10)

(1) Flaps, landing gear and deceleration devices in any likely combination of positions approved for operation;

(2) Representative weights within the range for which certification is requested;

(3) The most adverse centre of gravity for recovery; and

(4) The aeroplane trimmed for straight flight at the speed prescribed in 525.103(b)(6). (amended 2003/11/10)

(c) The following procedures must be used to show compliance with 525.203:

(1) Starting at a speed sufficiently above the stalling speed to ensure that a steady rate of speed reduction can be established, apply the longitudinal control so that the speed reduction does not exceed one knot per second until the aeroplane is stalled.

(2) In addition, for turning flight stalls, apply the longitudinal control to achieve airspeed deceleration rates up to 3 knots per second.

(3) As soon as the aeroplane is stalled, recover by normal recovery techniques.

(d) The aeroplane is considered stalled when the behaviour of the aeroplane gives the pilot a clear and distinctive indication of an acceptable nature that the aeroplane is stalled. Acceptable indications of a stall, occurring either individually or in combination, are:

(1) A nose-down pitch that cannot be readily arrested;

(2) Buffeting, of a magnitude and severity that is a strong and effective deterrent to further speed reduction; or

(3) The pitch control reaches the aft stop and no further increase in pitch attitude occurs when the control is held full aft for a short time before recovery is initiated.

(Change 525-3 (91-11-01))
(Change 525-7 (96-09-30))

525.203 *Stall Characteristics*

(a) It must be possible to produce and to correct roll and yaw by unreversed use of the aileron and rudder controls, up to the time the aeroplane is stalled. No abnormal nose-up pitching may occur. The longitudinal control force must be positive up to and throughout the stall. In addition, it must be possible to promptly prevent stalling and to recover from a stall by normal use of the controls.

(b) For level wing stalls, the roll occurring between the stall and the completion of the recovery may not exceed approximately 20 degrees.

(c) For turning flight stalls, the action of the aeroplane after the stall may not be so violent or extreme as to make it difficult, with normal piloting skill, to effect a prompt recovery and to regain control of the aeroplane. The maximum bank angle that occurs during the recovery may not exceed:

(1) Approximately 60 degrees in the original direction of the turn, or 30 degrees in the opposite direction, for deceleration rates up to 1 knot per second; and

(2) Approximately 90 degrees in the original direction of the turn, or 60 degrees in the opposite direction, for deceleration rates in excess of 1 knot per second.

(Change 525-7 (96-09-30))

525.205 *(Removed)*

(Change 525-3 (91-11-01))

525.207 *Stall Warning*

(a) Stall warning with sufficient margin to prevent inadvertent stalling with the flaps and landing gear in any normal position shall be clear and distinctive to the pilot in straight and turning flight.
(amended 2003/11/10)

(b) The warning shall be furnished either through the inherent aerodynamic qualities of the aeroplane or by a device that will give clearly distinguishable indications under expected conditions of flight. However, a visual stall warning device that requires the attention of the flight crew within the cockpit is not acceptable by itself. If a warning device is used, it shall provide a warning in each of the aeroplane configurations prescribed in paragraph *(a)* of this section at the speed prescribed in paragraphs *(c)* and *(d)* of this section. Except for the stall warning prescribed in paragraph (h)(2)(ii) of this section, the stall warning for flight in icing conditions prescribed in paragraph (e) of this section shall be provded by the same means as the stall warning for flight in non-icing conditions. [a]In addition, a stall warning system, if required, shall provide an appropriate warning that is clearly audible to the flight crew under all foreseeable operating conditions.
(amended 2008/10/30)

[a] Canadian variation

FAR:

(b) The warning must be furnished either through the inherent aerodynamic qualities of the airplane or by a device that will give clearly distinguishable indications under expected conditions of flight. However, a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself. If a warning device is used, it must provide a warning in each of the airplane configurations prescribed in paragraph (a) of this section at the speed prescribed in paragraph (c) and (d) of this section. Except for the stall warning prescribed in paragraph (h)(2)(ii) of this section, the stall warning for flight in icing conditions prescribed in paragraph (e) of this section must be provided by the same means as the stall warning for flight in non-icing conditions.
(amended 2008/10/30)

(c) When the speed is reduced at rates not exceeding one knot per second, stall warning shall begin, in each normal configuration, at a speed, V_{SW}, exceeding the speed at which the stall is identified in accordance with 525.201*(d)* by not less than five knots or five percent CAS, whichever is greater. Once initiated, stall warning shall continue until the angle of attack is reduced to approximately that at which stall warning began.
(amended 2003/11/10)

(d) In addition to the requirement of subsection *(c)* of this section, when the speed is reduced at rates not exceeding one knot per second, in straight flight with engines idling and at the center of gravity position specified in 525.103*(b)*(5), V_{SW}, in each normal configuration,

shall exceed V_{SR} by not less than three knots or three percent CAS, whichever is greater.
(amended 2003/11/10)

(e) In icing conditions, the stall warning margin in straight and turning flight shall be sufficient to allow the pilot to prevent stalling (as defined in 525.201(d)) when the pilot starts a recovery maneuver not less than three seconds after the onset of stall warning. When demonstrating compliance with this paragraph, the pilot shall perform the recovery maneuver in the same way as for the aeroplane in non-icing conditions. Compliance with this requirement shall be demonstrated in flight with the speed reduced at rates not exceeding one knot per second, with:
(amended 2008/10/30)

(1) The more critical of the take-off ice and final take-off ice accretions defined in Appendix C for each configuration used in the take-off phase of flight;
(amended 2008/10/30)

(2) The en route ice accretion defined in Appendix C for the en route configuration;
(amended 2008/10/30)

(3) The holding ice accretion defined in Appendix C for the holding configuration(s);
(amended 2008/10/30)

(4) The approach ice accretion defined in Appendix C for the approach configuration(s); and
(amended 2008/10/30)

(5) The landing ice accretion defined in Appendix C for the landing and go-around configuration(s).
(amended 2008/10/30)

(f) The stall warning margin shall be sufficient in both non-icing and icing conditions to allow the pilot to prevent stalling when the pilot starts a recovery manoeuver not less than one second after the onset of stall warning in slow-down turns with at least 1.5g load factor normal to the flight path and airspeed deceleration rates of at least 2 knots per second. When demonstrating compliance with this paragraph for icing conditions, the pilot shall perform the recovery manoeuver in the same way as for the aeroplane in non-icing conditions. Compliance with this requirement shall be demonstrated in flight with:
(amended 2008/10/30)

(1) The flaps and landing gear in any normal position;
(amended 2008/10/30)

(2) The aeroplane trimmed for straight flight at a speed of 1.3 V_{SR}; and
(amended 2008/10/30)

(3) The power or thrust necessary to maintain level flight at 1.3 V_{SR}.
(amended 2008/10/30)

(g) Stall warning shall also be provided in each abnormal configuration of the high lift devices that is likely to be used in flight following system failures (including all configurations covered by *Aeroplane Flight Manual* procedures).
(amended 2008/10/30)

(h) For flight in icing conditions before the ice protection system has been activated and is performing its intended function, the following requirements apply, with the ice accretion defined in Appendix C, part II(e):
(amended 2008/10/30)

(1) If activating the ice protection system depends on the pilot seeing a specified ice accretion on a reference surface (not just the first indication of icing), the requirements of this section apply, except for paragraphs (c) and (d) of this section.
(amended 2008/10/30)

(2) For other means of activating the ice protection system, the stall warning margin in straight and turning flight shall be sufficient to allow the pilot to prevent stalling without encountering any adverse flight characteristics when the speed is reduced at rates not exceeding one knot per second and the pilot performs the recovery maneuver in the same way as for flight in non-icing conditions.
(amended 2008/10/30)

(i) If stall warning is provided by the same means as for flight in non-icing conditions, the pilot may not start the recovery manoeuver earlier than one second after the onset of stall warning.
(amended 2008/10/30)

(ii) If stall warning is provided by a different means than for flight in non-icing conditions, the pilot shall not start the recovery manoeuver earlier than 3 seconds after the onset of stall warning. Also, compliance shall be shown with 525.203 using the demonstration prescribed by 525.201, except that the deceleration rates of 525.201(c)(2) need not be demonstrated.
(amended 2008/10/30)

Ground and Water Handling Characteristics

525.231 *Longitudinal Stability and Control*

(a) Landplanes may have no uncontrollable tendency to nose over in any reasonably expected operating condition or when rebound occurs during landing or take-off. In addition:

(1) Wheel brakes shall operate smoothly and may not cause any undue tendency to nose over; and
(amended 2003/11/10)

(2) If a tail-wheel landing gear is used, it shall be possible, during the take-off ground run on concrete, to maintain any attitude up to thrust line level, at 75 percent of V_{SR1}.
(amended 2003/11/10)

(b) For seaplanes and amphibians, the most adverse water conditions safe for take-off, taxiing, and landing, shall be established.
(amended 2003/11/10)

525.233 *Directional Stability and Control*

(a) There may be no uncontrollable ground-looping tendency in 90° cross winds, up to a wind velocity of 20 knots or 0.2 V_{SR0}, whichever is greater, except that the wind velocity need not exceed 25 knots at any speed at which the aeroplane may be expected to be operated on the ground. This may be demonstrated while establishing the 90° cross component of wind velocity required by 525.237.
(amended 2003/11/10)

(b) Landplanes must be satisfactorily controllable, without exceptional piloting skill or alertness, in power-off landings at normal landing speed, without using brakes or engine power to maintain a straight path. This may be shown during power-off landings made in conjunction with other tests.

(c) The aeroplane must have adequate directional control during taxiing. This may be shown during taxiing prior to take-offs made in conjunction with other tests.

525.235 *Taxiing Condition*

The shock absorbing mechanism may not damage the structure of the aeroplane when the aeroplane is taxied on the roughest ground that may reasonably be expected in normal operation.

525.237 *Wind Velocities*

(a) For landplanes and amphibians, the following applies:
(amended 2008/10/30)

(1) A 90-degree cross component of wind velocity, demonstrated to be safe for take-off and landing, shall be established for dry runways and shall be at least 20 knots or 0.2 V_{SR0}, whichever is greater, except that it need not exceed 25 knots.
(amended 2008/10/30)

(2) The crosswind component for take-off established without ice accretions is valid in icing conditions.
(amended 2008/10/30)

(3) The landing crosswind component shall be established for:
(amended 2008/10/30)

(i) Non-icing conditions, and
(amended 2008/10/30)

(ii) Icing conditions with the landing ice accretion defined in Appendix C.
(amended 2008/10/30)

(b) For seaplanes and amphibians, the following applies:

(1) A 90-degree cross component of wind velocity, up to which take-off and landing is safe under all water conditions that may reasonably be expected in normal operation, shall be established and shall be at least 20 knots or 0.2 V_{SR0}, whichever is greater, except that it need not exceed 25 knots.
(amended 2003/11/10)

(2) A wind velocity, for which taxiing is safe in any direction under all water conditions that may reasonably be expected in normal operation, shall be established and shall be at least 20 knots or 0.2 V_{SR0}, whichever is greater, except that it need not exceed 25 knots. (amended 2003/11/10)

525.239 *Spray Characteristics, Control, and Stability on Water*

(a) For seaplanes and amphibians, during take-off, taxiing, and landing, and in the conditions set forth in paragraph *(b)* of this section, there may be no:

(1) Spray characteristics that would impair the pilot's view, cause damage, or result in the taking in of an undue quantity of water;

(2) Dangerously uncontrollable porpoising, bounding, or swinging tendency; or

(3) Immersion of auxiliary floats or sponsons, wing tips, propeller blades, or other parts not designed to withstand the resulting water loads.

(b) Compliance with the requirements of paragraph *(a)* of this section must be shown:

(1) In water conditions, from smooth to the most adverse condition established in accordance with 525.231;

(2) In wind and cross-wind velocities, water currents, and associated waves and swells that may reasonably be expected in operation on water;

(3) At speeds that may reasonably be expected in operation on water;

(4) With sudden failure of the critical engine at any time while on water; and

(5) At each weight and centre of gravity position, relevant to each operating conditions, within the range of loading conditions for which certification is requested.

(c) In the water conditions of paragraph *(b)* of this section, and in the corresponding wind conditions, the seaplane or amphibian must be able to drift for five minutes with engines inoperative, aided, if necessary, by a sea anchor.

Miscellaneous Flight Requirements

525.251 *Vibration and Buffeting*

(a) The aeroplane must be demonstrated in flight to be free from any vibration and buffeting that would prevent continued safe flight in any likely operating condition.

(b) Each part of the aeroplane must be demonstrated in flight to be free from excessive vibration under any appropriate speed and power conditions up to V_{DF}/M_{DF}. The maximum speeds shown must be used in establishing the operating limitations of the aeroplane in accordance with 525.1505.

(c) Except as provided in paragraph *(d)*, there may be no buffeting condition, in normal flight, including configuration changes during cruise, severe enough to interfere with the control of the aeroplane, to cause excessive fatigue to the crew, or to cause structural damage. Stall warning b buffeting within these limits is allowable.

(d) There may be no perceptible buffeting condition in the cruise configuration in straight flight at any speed up to V_{MO}/M_{MO}, except that stall warning buffeting is allowable.

(e) For an aeroplane with M_D greater than 6 or with a maximum operating altitude greater than 25,000 feet, the positive manoeuvring load factors at which the onset of perceptible buffeting occurs must be determined with the aeroplane in the cruise configuration for the ranges of airspeed or Mach number, weight, and altitude for which the aeroplane is to be certificated. The envelopes of load factor, speed, altitude, and weight must provide a sufficient range of speeds and load factors for normal operations. Probable inadvertent excursions beyond the boundaries of the buffet onset envelopes may not result in unsafe conditions.

(Change 525-3 (91-11-01))
(Change 525-5 (92-10-30))

525.253 *High-Speed Characteristics*

(a) Speed Increase and Recovery Characteristics. The following speed increase and recovery characteristics must be met:

(1) Operating conditions and characteristics likely to cause inadvertent speed increases (including upsets in pitch and roll) must be simulated with the aeroplane trimmed at any likely cruise speed up to V_{MO}/M_{MO}. These conditions and characteristics include gust upsets, inadvertent control movements, low stick force gradient in relation to control friction, passenger movement, levelling off from climb, and descent from Mach to airspeed limit altitudes.

(2) Allowing for pilot reaction time after effective inherent or artificial speed warning occurs, it must be shown that the aeroplane can be recovered to a normal altitude and its speed reduced to V_{MO}/M_{MO}, without:

(i) Exceptional piloting strength or skill;

(ii) Exceeding V_D/M_D V_{DF}/M_{DF}, or the structural limitations; and

(iii) Buffeting that would impair the pilot's ability to read the instruments or control the aeroplane for recovery.

(3) With the aeroplane trimmed at any speed up to V_{MO}/M_{MO}, there must be no reversal of the response to control input about any axis at any speed up to V_{DF}/M_{DF}. Any tendency to pitch, roll, or yaw must be mild and readily controllable, using normal piloting techniques. When the aeroplane is trimmed at V_{MO}/M_{MO}, the slope of the elevator control force versus speed curve need not be stable at speeds greater than V_{FC}/M_{FC}, but there must be a push force at all speeds up to V_{DF}/M_{DF} and there must be no sudden or excessive reduction of elevator control force as V_{DF}/M_{DF} is reached.

(b) Maximum speed for stability characteristics, V_{FC}/M_{FC}. V_{FC}/M_{FC} is the maximum speed at which the requirements of 525.143*(g)*, 525.147*(e)*, 525.175*(b)*(1), 525.177, and 525.181 shall be met with flaps and landing gear retracted. Except as noted in 525.253(c), V_{FC}/M_{FC} shall not be less than a speed midway between V_{MO}/M_{MO} and V_{DF}/M_{DF}, except that for altitudes where Mach number is the limiting factor, M_{FC} need not exceed the Mach number at which effective speed warning occurs.
(amended 2008/10/30)

(c) Maximum speed for stability characteristics in icing conditions. The maximum speed for stability characteristics with the ice accretions defined in Appendix C, at which the requirements of 525.143(g), 525.147(e), 525.175(b)(1), 525.177 and 525.181 shall be met, is the lower of:
(amended 2008/10/30)

(1) 300 knots CAS;
(amended 2008/10/30)

(2) V_{FC}; or
(amended 2008/10/30)

(3) A speed at which it is demonstrated that the airframe will be free of ice accretion due to the effects of increased dynamic pressure.
(amended 2008/10/30)

(Change 525-3 (91-11-01))
(Change 525-7 (96-09-30))

525.255 *Out-of-Trim Characteristics*

(a) From an initial condition with the aeroplane trimmed at cruise speeds up to V_{MO}/M_{MO}, the aeroplane must have satisfactory manoeuvring stability and controllability with the degree of out-of-trim in both the aeroplane nose-up and nose-down directions, which results from the greater of:

(1) A three-second movement of the longitudinal trim system at its normal rate for the particular flight condition with no aerodynamic load (or an equivalent degree of trim for aeroplanes that do not have a power-operated trim system), except as limited by stops in the trim system, including those required by 525.655(b) for adjustable stabilisers; or

(2) The maximum mistrim that can be sustained by the autopilot while maintaining level flight in the high speed cruising condition.

(b) In the out-of-trim condition specified in paragraph *(a)* of this section, when the normal acceleration is varied from +1 g to the positive and negative values specified in paragraph *(c)* of this section:

(1) The stick force vs. g curve must have a positive slope at any speed up to and including V_{FC}/M_{FC}; and

(2) At speeds between V_{FC}/M_{FC} and V_{DF}/M_{DF} the direction of the primary longitudinal control force may not reverse.

(c) Except as provided in paragraphs *(d)* and *(e)* of this section, compliance with the provisions of paragraph *(a)* of this section must be demonstrated in flight over the acceleration range:

(1) -1g to +2.5 g; or

(2) 0 g to 2.0 g, and extrapolating by an acceptable method to -1 g and +2.5 g.

(d) If the procedure set forth in paragraph *(c)*(2) of this section is used to demonstrate compliance and marginal conditions exist during flight test with regard to reversal of primary

longitudinal control force, flight tests must be accomplished from the normal acceleration at which a marginal condition is found to exist to the applicable limit specified in paragraph *(b)*(1) of this section.

(e) During flight tests required by paragraph *(a)* of this section, the limit manoeuvring load factors prescribed in 525.333*(b)* and 525.337, and the manoeuvring load factors associated with probable inadvertent excursions beyond the boundaries of the buffet onset envelopes determined under 525.251*(e)*, need not be exceeded. In addition, the entry speeds for flight test demonstrations at normal acceleration values less than 1 g must be limited to the extent necessary to accomplish a recovery with out exceeding V_{DF}/M_{DF}.

(f) In the out-of-trim condition specified in paragraph *(a)* of this section, it must be possible from an overspeed condition at V_{DF}/M_{DF} to produce at least 1.5g for recovery by applying not more than 125 pounds of longitudinal control force using either the primary longitudinal control alone or the primary longitudinal control and the longitudinal trim system. If the longitudinal trim is used to assist in producing the required load factor, it must be shown at V_{DF}/M_{DF} that the longitudinal trim can be actuated in the aeroplane nose-up direction with the primary surface loaded to correspond to the least of the following aeroplane nose-up control forces:

(1) The maximum control forces expected in services as specified in 525.301 and 525.397.

(2) The control force required to produce 1.5g.

(3) The control force corresponding to buffeting or other phenomena of such intensity that it is a strong deterrent to further application of primary longitudinal control force.

SUBCHAPTER C

Structure - General

525.301 *Loads*

(a) Strength requirements are specified in terms of limit loads (the maximum loads to be expected in service) and ultimate loads (limit loads multiplied by prescribed factors of safety). Unless otherwise provided, prescribed loads are limit loads.

(b) Unless otherwise provided, the specified air, ground, and water loads must be placed in equilibrium with inertia forces, considering each item of mass in the aeroplane. .These loads must be distributed to conservatively approximate or closely represent actual conditions. Methods used to determine load intensities and distribution must be validated by flight load measurement unless the methods used for determining those loading conditions are shown to be reliable.

(c) If deflections under load would significantly change the distribution of external or internal loads, this redistribution must be taken into account.

525.303 *Factor of Safety*

Unless otherwise specified, a factor of safety of 1.5 must be applied to the prescribed limit load which are considered external loads on thè structure. When a loading condition is prescribed in terms of ultimate loads, a factor of safety need not be applied unless otherwise specified.

525.305 *Strength and Deformation*

(a) The structure must be able to support limit loads without detrimental permanent deformation. At any load up to limit loads, the deformation may not interfere with safe operation.

(b) The structure must be able to support ultimate loads without failure for at least 3 seconds. However, when proof of strength is shown by dynamic tests simulating actual load conditions, the 3-second limit does not apply. Static tests conducted to ultimate load must include the ultimate deflections and ultimate deformation induced by the loading. When analytical methods are used to show compliance with the ultimate load strength requirements, it must be shown that:

(1) The effects of deformation are not significant;

(2) The deformations involved are fully accounted for in the analysis; or

(3) The methods and assumptions used are sufficient to cover the effects of these deformations.

(c) Where structural flexibility is such that any rate of load application likely to occur in the operating conditions might produce transient stresses appreciably higher than those corresponding to static loads, the effects of this rate of application must be considered.

(d) Removed and Reserved

(e) The aeroplane must be designed to withstand any vibration and buffeting that might occur in any likely operating condition up to V_D/M_D, including stall and probable inadvertent excursions beyond the boundaries of the buffet onset envelope. This must be shown by analysis, flight tests, or other tests found necessary by the Minister.

(f) Unless shown to be extremely improbable, the aeroplane must be designed to withstand any forced structural vibration resulting from any failure, malfunction or adverse condition in the flight control system. These must be considered limit loads and must be investigated at airspeeds up to V_C/M_C.

(Change 525-5 (92-10-30))
(Change 525-8)

525.307 *Proof of Structure*

(a) Compliance with the strength and deformation requirements of this subchapter must be shown for each critical loading condition. Structural analysis may be used only if the structure conforms to those for which experience has shown this method to be reliable. The Minister may require ultimate load tests in cases where limit load tests may be inadequate.

(b) (Reserved)

(c) (Reserved)

(d) When static or dynamic tests are used to show compliance with the requirements of 525.305*(b)* for flight structures, appropriate material correction factors must be applied to the test results, unless the structure, or part thereof, being tested has features such that a

number of elements contribute to the total strength of the structure and the failure of one element results in the redistribution of the load through alternate load paths.

(Change 525-3 (91-11-01)

Flight Loads

525.321 *General*

(a) Flight load factors represent the ratio of the aerodynamic force component (acting normal to the assumed longitudinal axis of the aeroplane) to the weight of the aeroplane. A positive load factor is one in which the aerodynamic force acts upward with respect to the aeroplane.

(b) Considering compressibility effects at each speed, compliance with the flight load requirements of this subchapter must be shown:

(1) At each critical altitude within the range of altitudes selected by the applicant;

(2) At each weight from the design minimum weight to the design maximum weight appropriate to each particular flight load condition; and

(3) For each required altitude and weight, for any practicable distribution of disposable load within the operating limitations recorded in the *Aeroplane Flight Manual*.

(c) Enough points on and within the boundaries of the design envelope must be investigated to ensure that the maximum load for each part of the aeroplane structure is obtained.

(d) The significant forces acting on the aeroplane must be placed in equilibrium in a rational or conservative manner. The linear inertia forces must be considered in equilibrium with the thrust and all aerodynamic loads, while the angular (pitching) inertia forces must be considered in equilibrium with thrust and all aerodynamic moments, including moments due to loads on components such as tail surfaces and nacelles. Critical thrust values in the range from zero to maximum continuous thrust must be considered.

(Change 525-8)

Flight Manoeuvre and Gust Conditions

525.331 *Symmetric Manoeuvring Conditions*

(a) Procedure. For the analysis of the manoeuvring flight conditions specified in paragraphs *(b)* and *(c)* of this section, the following provisions apply:

(1) Where sudden displacement of a control is specified, the assumed rate of control surface displacement may not be less than the rate that could be applied by the pilot through the control system.

(2) In determining elevator angles and chordwise load distribution in the manoeuvring conditions of paragraphs (b) and (c) of this section, the effect of corresponding pitching velocities must be taken into account. The in-trim and out-of-trim flight conditions specified in 525.255 must be considered.

(b) Manoeuvring balanced conditions. Assuming the aeroplane to be in equilibrium with zero pitching acceleration, the manoeuvring conditions A through I on the manoeuvring envelope in 525.333*(b)* must be investigated.

(c) Pitch manoeuvring conditions. The conditions specified in paragraphs *(c)*(1) and (2) of this section must be investigated. The movement of the pitch control surfaces may be adjusted to take into account limitations imposed by the maximum pilot effort specified by 525.397*(b)*, control system stops and any indirect effect imposed by limitations in the output side of the control system (for example, stalling torque or maximum rate obtainable by a power control system).

(1) *Maximum pitch control displacement at V_A.* The aeroplane is assumed to be flying in steady level flight (point A_1, 525.333(b)) and the cockpit pitch control is suddenly moved to obtain extreme nose up pitching acceleration. In defining the tail load, the response of the aeroplane must be taken into account. Aeroplane loads that occur subsequent to the time when normal acceleration at the c.g. exceeds the positive limit manoeuvring load factor (at point A_2, 525.333(b)), or the resulting tailplane normal load reaches its maximum, whichever occurs first, need not be considered.

(2) *Specified control displacement.* A checked manoeuvre, based on a rational pitching control motion vs., time profile, must be established in which the design limit load factor specified in 525.337 will not be exceeded. Unless lesser values cannot be exceeded, the aeroplane response must result in pitching accelerations not less than the following:

(i) A positive pitching acceleration (nose up) is assumed to be reached concurrently with the aeroplane load factor of 1.0 (points A_1 to D_1, 525.333(b)). The positive acceleration must be equal to at least:

$$\frac{39n}{V}(n-1{,}5),\ (Radians/\sec^2)$$

where:

'n' is the positive load factor at the speed under consideration; and V is the aeroplane equivalent speed in knots.

(ii) A negative pitching acceleration (nose down) is assumed to be reached concurrently with the positive manoeuvring load factor (points A_2 to D_2, 525.333(b)). This negative pitching acceleration must be equal to at least

$$\frac{-26n}{V}(n-1{,}5),\ (Radians/\sec^2)$$

where:

'n' is the positive load factor at the speed under consideration; and V is the aeroplane equivalent speed in knots.

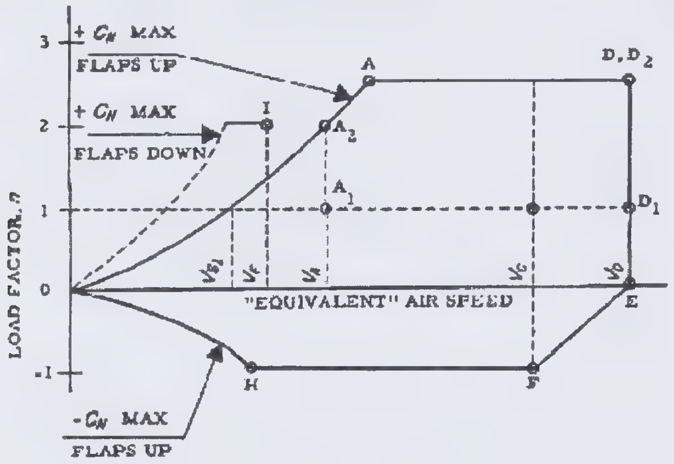
(d) Removed

(Change 525-3 (91-11-01)
(Change 525-8)

525.333 *Flight Manoeuvring Envelope*

(a) General. The strength requirements must be met at each combination of airspeed and load factor on and within the boundaries of the representative manoeuvring envelope (V_{-n} diagram) of paragraph *(b)* of this section. This envelope must also be used in determining the aeroplane structural operating limitations as specified in 525.1501.

(b) Manoeuvring Envelope.



(c) Removed

(Change 525-8)

525.335 *Design Airspeeds*

The selected design airspeeds are equivalent airspeeds (EAS). Estimated values of V_{SO} and V_{S1} must be conservative.

(a) Design cruising speed, V_C. For V_C, the following apply:

(1) The minimum value of V_C must be sufficiently greater than V_B to provide for inadvertent speed increases likely to occur as a result of severe atmospheric turbulence. (amended 2012/03/27)

(2) Except as provided in 525.335(d)(2), V_C may not be less than V_B + 1.32 U_{REF} (with U_{REF} as specified in 525.341(a)(5)(i)). However, V_C need not exceed the maximum speed in level flight at maximum continuous power for the corresponding altitude.

(3) At altitudes where V_D is limited by Mach number, V_C may be limited to a selected Mach number.

(b) Design dive speed, V_D. V_D must be selected so that V_C/M_C is not greater than 0.8 V_D/M_D, or so that the minimum speed margin between V_C/M_C and V_D/M_D is the greater of the following values:

(1) From an initial condition of stabilised flight at V_C/M_C, the aeroplane is upset, flown for 20 seconds along a flight path of 7.5° below the initial path, and then pulled up at a load

factor of 1.5g (0.5g acceleration increment). The speed increase occurring in this manoeuvre may be calculated if reliable or conservative aerodynamic data issued. Power as specified in 525.175(b)(1)(iv) is assumed until the pull-up is initiated, at which time power reduction and the use of pilot controlled drag devices may be assumed;

(2) The minimum speed margin must be enough to provide for atmospheric variations (such as horizontal gusts, and penetration of jet streams and cold fronts) and for instrument errors and airframe production variations. These factors may be considered on a probability basis. The margin at altitude where M_C is limited by compressibility effects must not be less than 0.07M unless a lower margin is determined using a rational analysis that includes the effects of any automatic systems. In any case, the margin may not be reduced to less than 0.05M.

(c) Design manoeuvring speed, V_A. For V_A, the following apply:

(1) V_A may not be less than

$$V_{S1}\sqrt{n}$$

where:

(i) n is the limit positive manoeuvring load factor at V_C; and

(ii) V_{S1} is the stalling speed with flaps retracted.

(2) V_A and V_S must be evaluated at the design weight and altitude under consideration.

(3) V_A need not be more than V_C or the speed at which the positive C_{Nmax} curve intersects the positive manoeuvre load factor line, whichever is less.

(d) Design speed for maximum gust intensity, V_B.

(1) V_B may not be less than:

$$V_{S1}\left[1+\frac{K_g\ U_{ref}\ V_c a}{498w}\right]^{½}$$

where:

V_{S1} = the 1-g stalling speed based on C_{NAmax} with the flaps retracted at the particular weight under consideration;

V_c = design cruise speed (knots equivalent airspeed);

U_{ref} = the reference gust velocity (feet per second equivalent airspeed) from 525.341(a)(5)(i);

w = average wing loading (pounds per square foot) at the particular weight under consideration.

$$K_g=\frac{0{,}88\mu}{5{,}3+\mu}$$

$$\mu = \frac{2w}{\rho c a g}$$

ρ = density of air (slugs/ft^3;

c = mean geometric chord of the wing (feet);

g = acceleration due to gravity (ft/sec^2;

a = slope of the aeroplane normal force coefficient curve, C_{NA} per radian;

(2) At altitudes where V_C is limited by Mach number:

(i) V_B may be chosen to provide an optimum margin between low and high speed buffet boundaries; and,

(ii) V_B need not be greater than V_c.

(e) *Design flap speeds*, V_F. For V_F, the following apply:

(1) The design flap speed for each flap position (established in accordance with 525.697(a)) must be sufficiently greater than the operating speed recommended for the corresponding stage of flight (including balked landings) to allow for probable variations in control of airspeed and for transition from one flap position to another.

(2) If an automatic flap positioning or load limiting device is used, the speeds and corresponding flap positions programmed or allowed by the device may be used.

(3) V_F may not be less than:

(i) 1.6 V_{S1} with the flaps in take-off position at maximum take-off weight;

(ii) 1.8 V_{S1} with the flaps in approach position at maximum landing weight; and

(iii) 1.8 V_{SO} with the flaps in landing position at maximum landing weight.

(f) Design drag device speeds, V_{DD}. The selected design speed for each drag device must be sufficiently greater than the speed recommended for the operation of the device to allow for probable variations in speed control. For drag devices intended for use in high speed descents, V_{DD} may not be less than V_D. When an automatic drag device positioning or load limiting means is used, the speeds and corresponding drag device positions programmed or allowed by the automatic means must be used for design.

(Change 525-8)

525.337 *Limit Manoeuvring Load Factors*

(a) Except where limited by maximum (static) lift coefficients, the aeroplane is assumed to be subjected to symmetrical manoeuvres resulting in the limit manoeuvring load factors prescribed in this section. Pitching velocities appropriate to the corresponding pull-up and steady turn manoeuvres must be taken into account.

(b) The positive limit manoeuvring load factor "n" for any speed up to V_N may not be less than

$$2.1+\left(\frac{24{,}000}{W+10{,}000}\right)$$

except that "n" may not be less than 2.5 and need not be greater than 3.8 where "W" is the design maximum take-off weight.

(c) The negative limit manoeuvring load factor:

(1) May not be less than -1.0 at speeds up to V_C; and

(2) Must vary linearly with speed from the value at V_C to zero at V_D.

(d) Manoeuvring load factors lower than those specified in this section may be used if the aeroplane has design features that make it impossible to exceed these values in flight.

(Change 525-3 (91-11-01))

525.341 *Gust and Turbulence Loads*

(a) Discrete Gust Design Criteria. The aeroplane is assumed to be subjected to symmetrical vertical and lateral gusts in level flight. Limit gust loads must be determined in accordance with the provisions:

(1) Loads on each part of the structure must be determined by dynamic analysis. The analysis must take into account unsteady aerodynamic characteristics and all significant structural degrees of freedom including rigid body motions.

(2) The shape of the gust must be:

$$U=\frac{U_{ds}}{2}\left[1-\cos\left(\frac{\pi s}{H}\right)\right]$$

for $0 \le s \le 2H$

where:

s = distance penetrated into the gust (feet);

U_{ds} = the design gust velocity in equivalent airspeed specified in paragraph (a)(4) of this section; and

H = the gust gradient which is the distance (feet) parallel to the aeroplane's flight path for the gust to reach its peak velocity.

(3) A sufficient number of gust gradient distances in the range 30 feet to 350 feet must be investigated to find the critical response for each load quantity.

(4) The design gust velocity must be:

$$U_{ds}=U_{ref}F_g\left({}^{H}/350\right)^{1/6}$$

where:

U_{ref} = the reference gust velocity in equivalent airspeed defined in paragraph (a)(5) of this section.

F_g = the flight profile alleviation factor defined in paragraph (a)(6) of this section.

(5) The following reference gust velocities apply:

(i) At the aeroplane design speed V_C:

Positive and negative gusts with reference gust velocities of 56.0 ft/sec EAS must be considered at sea level. The reference gust velocity may be reduced linearly from 56.0 ft/sec EAS at sea level to 44.0 ft/sec EAS at 15,000 feet. The reference gust velocity may be further reduced linearly from 44.0 ft/sec EAS at 15,000 feet to 26.0 ft/sec EAS at 50,000 feet.

(ii) At the aeroplane design speed V_D:

The reference gust velocity must be 0.5 times the value obtained under 525.341(a)(5)(i).

(6) The flight profile alleviation factor, F_g, must be increased linearly from the sea level value to a value of 1.0 at the maximum operating altitude defined in 525.1527. At sea level, the flight profile alleviation factor is determined by the following equation:

$$F_g = 0{,}5\left(F_{gz} + F_{gm}\right)$$

where:

$$F_{gm} = 1 - \frac{Z_{mo}}{250\ 000}$$

$$F_{gm} = \sqrt{R_2 Tan\left({}^{\pi R} 1/4\right)}$$

$$R_1 = \frac{\text{Maximum Landing Weight}}{\text{Maximum Take-off Weight}};$$

$$R_2 = \frac{\text{Maximum Zero Fuel Weight}}{\text{Maximum Take-off Weight}};$$

Z_{mo} = Maximum operating altitude defined in 525.1527.

(7) When a stability augmentation system is included in the analysis, the effect of any significant system nonlinearities should be accounted for when deriving limit loads from limit gust conditions.

(b) Continuous Gust Design Criteria. The dynamic response of the aeroplane to vertical and lateral continuous turbulence must be taken into account. The continuous gust design criteria of Appendix G of this chapter must be used to establish the dynamic response unless more rational criteria are shown.

(Change 525-3 (91-11-01))

(Change 525-8)

525.343 *Design Fuel and Oil Loads*

(a) The disposable load combinations must include each fuel and oil load in the range from zero fuel and oil to the selected maximum fuel and oil load. A structural reserve fuel condition, not exceeding 45 minutes of fuel under the operating conditions in 525.1001*(e)* and *(f)*, as applicable, may be selected.

(b) If a structural reserve fuel condition is selected, it must be used as the minimum fuel weight condition for showing compliance with the flight load requirements as prescribed in this subchapter. In addition:

(1) The structure must be designed for a condition of zero fuel and oil in the wing at limit loads corresponding to:

(i) A manoeuvring load factor of +2.25; and

(ii) The gust conditions of 525.341(a) but assuming 85% of the design velocities prescribed in 525.341(a)(4).

(2) Fatigue evaluation of the structure must account for any increase in operating stresses resulting from the design condition of subparagraph (b)(1) of this paragraph; and

(3) The flutter, deformation, and vibration requirements must also be met with zero fuel.

(Change 525-3 (91-11-01))
(Change 525-8)

525.345 *High Lift Devices*

(a) If wing flaps are to be used during take-off, approach, or landing, at the design flap speeds established for these stages of flight under 525.335*(e)* and with the wing flaps in the corresponding positions, the aeroplane is assumed to be subjected to symmetrical manoeuvres and gusts. The resulting limit loads must correspond to the conditions determined as follows:

(1) Manoeuvring to a positive limit load factor of 2.0; and

(2) Positive and negative gusts of 25 ft/sec EAS acting normal to the flight path in level flight. Gust loads resulting on each part of the structure must be determined by rational analysis. The analysis must take into account the unsteady aerodynamic characteristics and rigid body motions of the aircraft. The shape of the gust must be as described in 525.341(a)(2) except that:

U_{ds} = 25 ft/sec EAS;

H = 12.5 c; and

c = mean geometric chord of the wing (feet).

(b) The aeroplane must be designed for the conditions prescribed in paragraph *(a)* of this section, except that the aeroplane load factor need not exceed 1.0, taking into account, as separate conditions, the effects of:

(1) Propeller slipstream corresponding to maximum continuous power at the design flap speeds V_F, and with take-off power at not less than 1.4 times the stalling speed for the particular flap position and associated maximum weight; and

(2) A head-on gust of 25 feet per second velocity (EAS).

(c) If flaps or other high lift devices are to be used in en route conditions, and with flaps in the appropriate position at speeds up to the flap design speed chosen for these conditions, the aeroplane is assumed to be subjected to symmetrical manoeuvres and gusts within the range determined by:

(1) Manoeuvring to a positive limit load factor as prescribed in 525.337(b); and

(2) The discrete vertical gust criteria in 525.341(a).

(d) The aeroplane must be designed for a manoeuvring load factor of 1.5 g at the maximum take-off weight with the wing-flaps and similar high lift devices in the landing configurations.

(Change 525-3 (91-11-01))
(Change 525-8)

525.349 *Rolling Conditions*

The aeroplane must be designed for loads resulting from the rolling conditions specified in paragraphs (a) and (b) of this section. Unbalanced aerodynamic moments about the centre of gravity must be reacted in a rational or conservative manner, considering the principal masses furnishing the reacting inertia forces.

(a) Manoeuvring. The following conditions, speeds, and aileron deflections (except as the deflections may be limited by pilot effort) must be considered in combination with an aeroplane load factor of zero and of two-thirds of the positive manoeuvring factor used in design. In determining the required aileron deflections, the torsional flexibility of the wing must be considered in accordance with 525.301*(b)*:

(1) Conditions corresponding to steady rolling velocities must be investigated. In addition, conditions corresponding to maximum angular acceleration must be investigated for aeroplanes with engines or other weight concentrations outboard of the fuselage. For the angular acceleration conditions, zero rolling velocity may be assumed in the absence of a rational time history investigation of the manoeuvre.

(2) At V_A, a sudden deflection of the aileron to the stop is assumed.

(3) At V_C, the aileron deflection must be that required to produce a rate of roll not less than that obtained in subparagraph (2) of this paragraph.

(4) At V_D, the aileron deflection must be that required to produce a rate of roll not less than one-third of that in subparagraph (2) of this paragraph.

(b) Unsymmetrical gusts. The aeroplane is assumed to be subjected to unsymmetrical vertical gusts in level flight. The resulting limit loads must be determined from either the wing maximum airload derived directly from 525.341*(a)*, or the wing maximum airload derived indirectly from the vertical load factor calculated from 525.341*(a)*. It must be assumed that 100 percent of the wing air load acts on one side of the aeroplane and 80 percent of the wing air load acts on the other side.

(Change 525-8)

525.351 *Yaw Manoeuvre Conditions*

The aeroplane must be designed for loads resulting from the yaw manoeuvre conditions specified in paragraphs (a) through (d) of this section at speeds from V_{MC} to V_D. Unbalanced aerodynamic moments about the centre of gravity must be reacted in a rational or conservative manner considering the aeroplane inertia forces. In computing the tail loads the yawing velocity may be assumed to be zero.

(a) With the aeroplane in unaccelerated flight at zero yaw, it is assumed that the cockpit rudder control is suddenly displaced to achieve the resulting rudder deflection, as limited by:

(1) The control system on control surface stops; or

(2) A limit pilot force of 300 pounds from V_{MC} to V_A and 200 pounds from V_C/M_C to V_D/M_D, with a linear variation between V_A and V_C/M_C.

(b) With the cockpit rudder control deflected so as always to maintain the maximum rudder deflection available within the limitations specified in paragraph *(a)* of this section, it is assumed that the aeroplane yaws to the overswing sideslip angle.

(c) With the aeroplane yawed to the static equilibrium sideslip angle, it is assumed that the cockpit rudder control is held so as to achieve the maximum rudder deflection available within the limitations specified in paragraph *(a)* of this section.

(d) With the aeroplane yawed to the static equilibrium sideslip angle of paragraph *(c)* of this section, it is assumed that the cockpit rudder control is suddenly returned to neutral.

(Change 525-3 (91-11-01))
(Change 525-8)

Supplementary Conditions

525.361 *Engine Torque*

(a) Each engine mount and its supporting structure must be designed for the effects of:

(1) A limit engine torque corresponding to take-off power and propeller speed acting simultaneously with 75 percent of the limit loads from flight condition A of 525.333(b);

(2) A limit torque corresponding to the maximum continuous power and propeller speed acting simultaneously with the limit loads from flight condition A of 525.333(b); and

(3) For turbopropeller installations, in addition to the conditions specified in subparagraphs (1) and (2) of this paragraph, a limit engine torque corresponding to take-off power and propeller speed, multiplied by a factor accounting for propeller control system malfunction, including quick feathering, acting simultaneously with 1_g level flight loads. In the absence of a rational analysis, a factor of 1.6 must be used.

(b) For turbine engine installations, the engine mounts and supporting structure must be designed to withstand each of the following:

(1) A limit engine torque load imposed by sudden engine stoppage due to malfunction or structural failure (such as compressor jamming).

(2) A limit engine torque load imposed by the maximum acceleration of the engine.

(c) The limit engine torque to be considered under paragraphs *(a)* of this section must be obtained by multiplying the mean torque for the specific power and speed by a factor of:

(1) 1.25 for turbopropeller installations;

(2) 1.33 for reciprocating engines with five or more cylinders; or

(3) Two, three, or four, for engines with four, three, or two cylinders, respectively.

(Change 525-3 (91-11-01))

525.363 *Side Load on Engine and Auxiliary Power Unit Mounts*

(a) Each engine and auxiliary power unit mount and its supporting structure must be designed for a limit load factor in lateral direction, for the side load on the engine and auxiliary power unit mount, at least equal to the maximum load factor obtained in the yawing conditions but not less than:

(1) 1.33; or

(2) One-third of the limit load factor for flight condition A as prescribed in 525.333(b).

(b) The side load prescribed in paragraph *(a)* of this section may be assumed to be independent of other flight conditions.

(Change 525-8)

525.365 *Pressurised Compartment Loads*

For aeroplanes with one or more pressurised compartments, the following apply:

(a) The aeroplane structure must be strong enough to withstand the flight loads combined with pressure differential loads from zero up to the maximum relief valve setting.

(b) The external pressure distribution in flight, and stress concentrations and fatigue effects must be accounted for.

(c) If landings may be made with the compartment pressurised, landing loads must be combined with pressure differential loads from zero up to the maximum allowed during landing.

(d) The aeroplane structure must be designed to be able to withstand the pressure differential loads corresponding to the maximum relief valve setting multiplied by a factor of 1.33 for aeroplanes to be approved for operation to 45,000 feet or by a factor of 1.67 for aeroplanes to be approved for operation above 45,000 feet, omitting other loads.

(e) Any structure, component or part inside or outside a pressurised compartment, the failure of which could interfere with continued safe flight and landing, must be designed to withstand the effects of a sudden release of pressure through an opening in any compartment at any approved operating altitude resulting from each of the following conditions:

(1) The penetration of the compartment by a portion of an engine following an engine disintegration;

(2) Any opening in any pressurised compartment up to the size H_o in square feet; however, small compartments may be combined with an adjacent pressurised compartment and both considered as a single compartment for openings that cannot reasonably be expected to be confined to the small compartment. The size H_o must be computed by the following formula:

$$H_o = PA_s$$

where:

H_o = maximum opening in square feet, not to exceed 20 square feet;

$P = A_S/6{,}240 + 0.024$;

A_S = maximum cross sectional area of pressurised shell normal to the longitudinal axis, in square feet; and

(3) The maximum opening caused by aeroplane or equipment failures not shown to be extremely improbable.

(f) In complying with paragraph *(e)* of this section, the fail-safe features of the design may be considered in determining the probability of failure or penetration and probable size of openings, provided that possible improper operation of closure devices and inadvertent door openings are also considered. Furthermore, the resulting differential pressure loads must be combined in a rational and conservative manner with 1-g level flight loads and any loads arising from emergency de-pressurisation conditions. These loads may be considered as ultimate conditions; however, any deformations associated with these conditions must not interfere with continued safe flight and landing. The pressure relief provided by inter-compartment venting may also be considered.

(g) Bulkheads, floors and partitions in pressurised compartments for occupants must de designed to withstand the conditions specified in paragraph *(e)* of this section. In addition, reasonable design precautions must be taken to minimise the probability of parts becoming detached and injuring occupants while in their seats.

(Change 525-3 (91-11-01))

(Change 525-8)

525.367 *Unsymmetrical Loads Due to Engine Failure*

(a) The aeroplane must be designed for the unsymmetrical loads resulting from the failure of the critical engine. Turbopropeller aeroplanes must be designed for the following conditions in combination with a single malfunction of the propeller drag limiting system, considering the probable pilot corrective action on the flight controls:

(1) At speeds between V_{MC} and V_D, the loads resulting from power failure because of fuel flow interruption are considered to be limit loads.

(2) At speeds between V_{MC} and V_C, the loads resulting from the disconnection of the engine compressor from the turbine or from loss of the turbine blades are considered to be ultimate loads.

(3) The time history of the thrust decay and drag build-up occurring as a result of the prescribed engine failures must be substantiated by test or other data applicable to the particular engine-propeller combination.

(4) The timing and magnitude of the probable pilot corrective action must be conservatively estimated, considering the characteristics of the particular engine-propeller aeroplane combination.

(b) Pilot corrective action may be assumed to be initiated at the time maximum yawing velocity is reached, but not earlier than two seconds after the engine failure. The magnitude of the corrective action may be based on the control forces specified in 525.397*(b)* except that lower forces may be assumed where it is shown by analysis or test that these forces can control the yaw and roll resulting from the prescribed engine failure conditions.

525.371 *Gyroscopic Loads*

The structure supporting any engine or auxiliary power unit must be designed for the loads including the gyroscopic loads arising from the conditions specified in 525.331, 525.341*(a)*, 525.349, 525.351, 525.473, 525.479, and 525.481, with the engine or auxiliary power unit at the maximum rpm appropriate to the condition. For the purposes of compliance with this section, the pitch manoeuvre in 525.331*(c)*(1) must be carried out until the positive limit manoeuvring load factor (point A_2 in 525.333*(b)*) is reached.

(Change 525-8)

525.373 *Speed Control Devices*

If speed control devices (such as spoilers and drag flaps) are installed for use in en route conditions:

(a) The aeroplane must be designed for the symmetrical manoeuvres prescribed in 525.333 and 525.337, the yawing manoeuvres prescribed in 525.351, and the vertical and lateral gust conditions prescribed in 525.341*(a)*, at each setting and the maximum speed associated with that setting; and

(b) If the device has automatic operating or load limiting features, the aeroplane must be designed for the manoeuvre and gust conditions prescribed in paragraph *(a)* of this section, at the speeds and corresponding device positions that the mechanism allows.

(Change 525-3 (91-11-01))
(Change 525-8)

Control Surface and System Loads

525.391 *Control Surface Loads: General*

The control surfaces must be designed for the limit loads resulting from the flight conditions in 525.331, 525.341(a), 525.349 and 525.351 and the ground gust conditions in 525.415, considering the requirements for:

(a) Loads parallel to hinge line, in 525.393;

(b) Pilot effort effects, in 525.397;

(c) Trim tab effects, in 525.407;

(d) Unsymmetrical loads, in 525.427; and

(e) Auxiliary aerodynamic surfaces, in 525.445.

(Change 525-8)

525.393 *Loads Parallel to Hinge Line*

(a) Control surfaces and supporting hinge brackets must be designed for inertia loads acting parallel to the hinge line.

(b) In the absence of more rational data, the inertia loads may be assumed to be equal to KW, where:

(1) K = 24 for vertical surfaces;

(2) K = 12 for horizontal surfaces; and

(3) W = weight of the movable surfaces.

525.395 *Control System*

(a) Longitudinal, lateral, directional and drag control systems and their supporting structures must be designed for loads corresponding to 125 percent of the computed hinge moments of the movable control surface in the conditions prescribed in 525.391.

(b) The system limit loads, except the loads resulting from ground gusts, need not exceed the loads that can be produced by the pilot (or pilots) and by automatic or power devices operating the controls.

(c) The loads must not be less than those resulting from application of the minimum forces prescribed in 525.397*(c)*.

(Change 525-3 (91-11-01))

525.397 *Control System Loads*

(a) General. The maximum and minimum pilot forces, specified in paragraph *(c)* of this section, are assumed to act at the appropriate control grips or pads (in a manner simulating flight conditions) and to be reacted at the attachment of the control system to the control surface horn.

(b) Pilot effort effects. In the control surface flight loading condition, the air loads on movable surfaces and the corresponding deflections need not exceed those that would result in flight from the application of any pilot force within the ranges specified in paragraph *(c)* of this section. Two thirds of the maximum values specified for the aileron and elevator may be used if control surface hinge moments are based on reliable data. In applying this criterion, the effects of servo mechanisms, tabs, and automatic pilot systems, must be considered.

(c) Limit pilot forces and torques. The limit pilot forces and torques are as follows:

Control	Maximum forces or torques	Minimum forces or torques
Aileron:		
Stick	100 lbs.	40 lbs.
Wheel[1]	80 D in.-lbs.[2]	40 D in.-lbs.
Elevator:		
Stick	250 lbs.	100 lbs.
Wheel (symmetrical)	300 lbs.	100 lbs.
Wheel (unsymmetrical)[3]	300 lbs.	100 lbs.
Rudder		130 lbs.
[1] *The critical parts of the aileron control system must be designed for a single tangential force with a limit value equal to 1.25 times the couple force determined from these criteria.* [2] *D = wheel diameter (inches)* [3] *The unsymmetrical forces must be applied at one of the normal handgrip points on the periphery of the control wheel.*		

525.399 *Dual Control System*

(a) Each dual control system must be designed for the pilots operating in opposition, using individual pilot forces not less than:

(1) 0.75 times those obtained under 525.395; or

(2) The minimum forces specified in 525.397 (c).

(b) The control system must be designed for pilot forces applied in the same direction, using individual pilot forces not less than 0.75 times those obtained under 525.395.

525.405 *Secondary Control System*

Secondary controls, such as wheel brake, spoiler, and tab controls, must be designed for the maximum forces that a pilot is likely to apply to those controls. The following values may be used:

PILOT CONTROL FORCE LIMITS (SECONDARY CONTROLS)

Control	Limit Pilot Forces
Miscellaneous:	
*Crank, wheel, or lever.	$\frac{1+R}{3}$ x 50 lbs., but not less than 50 lbs. nor more than 150 lbs. (R=radius) (Applicable to any angle within 20° of plane of control).
Twist	133 in.-lbs.
Push-pull	To be chosen by applicant.
* Limited to flap, tab, stabiliser, spoiler, and landing gear operation controls.	

525.407 *Trim Tab Effects*

The effects of trim tabs on the control surface design conditions must be accounted for only where the surface loads are limited by maximum pilot effort. In these cases, the tabs are considered to be deflected in the direction that would assist the pilot, and the deflections are:

(a) For elevator trim tabs, those required to trim the aeroplane at any point within the positive portion of the pertinent flight envelope in 525.333*(b)*, except as limited by the stops; and

(b) For aileron and rudder trim tabs, those required to trim the aeroplane in the critical unsymmetrical power and loading conditions, with appropriate allowance for rigging tolerances.

525.409 *Tabs*

(a) Trim tabs. Trim tabs must be designed to withstand loads arising from all likely combinations of tab setting, primary control position, and aeroplane speed (obtainable without exceeding the flight load conditions prescribed for the aeroplane as a whole), when the effect of the tab is opposed by pilot effort forces up to those specified in 525.397*(b)*.

(b) Balancing tabs. Balancing tabs must be designed for deflections consistent with the primary control surface loading conditions.

(c) Servo tabs. Servo tabs must be designed for deflections consistent with the primary control surface loading conditions obtainable within the pilot manoeuvring effort, considering possible opposition from the trim tabs.

525.415 *Ground Gust Conditions*

(a) The control system must be designed as follows for control surface loads due to ground gusts and taxiing downwind:

(1) The control system between the stops nearest the surfaces and the cockpit controls must be designed for loads corresponding to the limit hinge moments H of subparagraphs (2) of this paragraph. These loads need not exceed:

(i) The loads corresponding to the maximum pilot loads in 525.397(c) for each pilot alone; or

(ii) 0.75 times these maximum loads for each pilot when the pilot forces are applied in the same direction.

(2) The control system stops nearest the surfaces, the control system locks, and the parts of the systems (if any) between these stops and locks and the control surface horns, must be designed for limit hinge moments H, in foot pounds, obtained from the formula:

$H = .0034KV^2cS$, where:

$V = 65$ (wind speed in knots)

K = limit hinge moment factor for ground gusts derived in paragraph (b) of this section.

c = mean chord of the control surface aft of the hinge line (ft); and

S = area of the control surface aft of the hinge line (sq. ft).

(b) The limit hinge moment factor K for ground gusts must be derived as follows:

Surface	K	Position Of Controls
(a) Aileron	0.75	Control column locked or lashed in mid-position.
(b) Aileron	[1]$\pm$0.50	Ailerons at full throw.
(c) Elevator	[1]$\pm$0.75	Elevator full down.
(d) Elevator	[1]$\pm$0.75	Elevator full up.
(e) Rudder	0.75	Rudder in neutral. (amended 2008/06/30)
(f) Rudder	0.75	Rudder at full throw.
[1]A positive value of K indicates a moment tending to depress the surface, while a negative value of K indicates a moment tending to raise the surface.		

(Change 525-3 (91-11-01))
(Change 525-8)

525.427 *Unsymmetrical Loads*

(a) In designing the aeroplane for lateral gust, yaw manoeuvre and roll manoeuvre conditions, account must be taken of unsymmetrical loads on the empennage arising from effects such as slipstream and aerodynamic interference with the wing, vertical fin and other aerodynamic surfaces.

(b) The horizontal tail must be assumed to be subjected to unsymmetrical loading conditions determined as follows:

(1) 100 percent of the maximum loading from the symmetrical manoeuvre conditions of 525.331 and the vertical gust conditions of 525.341(a) acting separately on the surface on one side of the plane of symmetry; and

(2) 80 percent of these loadings acting on the other side.

(c) For empennage arrangements where the horizontal tail surfaces have dihedral angles greater than plus or minus 10 degrees, or are supported by the vertical tail surfaces, the surfaces and the supporting structure must be designed for gust velocities specified in 525.341*(a)* acting in any orientation at right angles to the flight path.

(d) Unsymmetrical loading on the empennage arising from buffet conditions of 525.305*(e)* must be taken into account.

(Change 525-8)

525.445 *Auxiliary Aerodynamic Surfaces*

(a) When significant, the aerodynamic influence between auxiliary aerodynamic surfaces, such as outboard fins and winglets, and their supporting aerodynamic surfaces, must be taken into account for all loading conditions including pitch, roll, and yaw manoeuvres, and gusts as specified in 525.341*(a)* acting at any orientation at right angles to the flight path.

(b) To provide for unsymmetrical loading when outboard fins extend above and below the horizontal surface, the critical vertical surface loading (load per unit area) determined under 525.391 must also be applied as follows:

(1) 100 percent to the area of the vertical surfaces above (or below) the horizontal surface.

(2) 80 percent to the area below (or above) the horizontal surface.

(Change 525-8)

525.457 *Wing Flaps*

Wing flaps, their operating mechanisms, and their supporting structures must be designed for critical loads occurring in the conditions prescribed in 525.345, accounting for the loads occurring during transition from one flap position and airspeed to another.

525.459 *Special Devices*

The loading for special devices using aerodynamic surfaces (such as slats, and spoilers) must be determined from test data.

(Change 525-3 (91-11-01))

Ground Loads

525.471 *General*

(a) Loads and equilibrium. For limit ground loads:

(1) Limit ground loads obtained under this subchapter are considered to be external forces applied to the aeroplane structure; and

(2) In each specified ground load condition, the external loads must be placed in equilibrium with the linear and angular inertia loads in a rational or conservative manner.

(b) Critical centres of gravity. The critical centres of gravity within the range for which certification is requested must be selected so that the maximum design loads are obtained in each landing gear element. Fore and aft, vertical, and lateral aeroplane centres of gravity must be considered. Lateral displacements of the c.g. from the aeroplane centreline which would result in main gear loads not greater than 103 percent of the critical design load for symmetrical loading conditions may be selected without considering the effects of these lateral c.g. displacements on the loading of the main gear elements, or on the aeroplane structure provided.

(1) The lateral displacement of the c.g. results from random passenger or cargo disposition within the fuselage or from random unsymmetrical fuel loading or fuel usage; and

(2) Appropriate loading instructions for random disposable loads are included under the provisions of 525.1583(c)(1) to ensure that the lateral displacement of the centre of gravity is maintained within these limits.

(c) Landing gear dimension data. Figure 1 of Appendix A contains the basic landing gear dimension data.

525.473 *Landing Load Conditions and Assumptions*

(a) For the landing conditions specified in 525.479 to 525.485 the aeroplane is assumed to contact the ground:

(1) In the attitudes defined in 525.479 and 525.481;

(2) With a limit descent velocity of 10 fps at the design landing weight (the maximum weight for landing conditions at maximum descent velocity); and

(3) With a limit descent velocity of 6 fps at the design take-off weight (the maximum weight for landing conditions at a reduced descent velocity).

(4) The prescribed descent velocities may be modified if it is shown that the aeroplane has design features that make it impossible to develop these velocities.

(b) Aeroplane lift, not exceeding aeroplane weight, may be assumed unless the presence of systems or procedures significantly affects the lift.

(c) The method of analysis of aeroplane and landing gear loads must take into account at least the following elements:

(1) Landing gear dynamic characteristics.

(2) Spin-up and springback.

(3) Rigid body response.

(4) Structural dynamic response of the airframe, if significant.

(d) The landing gear dynamic characteristics shall be validated by tests as defined in paragraph 525.723*(a)*.
(amended 2001/10/01)

(e) The coefficient of friction between the tires and the ground may be established by considering the effects of skidding velocity and tire pressure. However, this coefficient of friction need not be more than 0.8.

(Change 525-8)

525.477 *Landing Gear Arrangement*

Sections 525.479 through 525.485 apply to aeroplanes with conventional arrangements of main and nose gears, or main and tail gears, when normal operating techniques are used.

525.479 *Level Landing Conditions*

(a) In the level attitude, the aeroplane is assumed to contact the ground at forward velocity components, ranging from V_{L1} to 1.25 V_{L2}, parallel to the ground under the conditions prescribed in 525.473 with:

(1) V_{L1} equal to V_{S0} (TAS) at the appropriate landing weight and in standard sea level conditions; and

(2) V_{L2} equal to V_{S0} (TAS) at the appropriate landing weight and altitudes in a hot day temperature of 41°F above standard.

(3) The effects of increased contact speed must be investigated if approval of downwind landings exceeding 10 knots is requested.

(b) For the level landing attitude for aeroplanes with tail wheels, the conditions specified in this section must be investigated with the aeroplane horizontal reference line horizontal in accordance with Figure 2 of Appendix A of this chapter.

(c) For the level landing attitude for aeroplanes with nose wheels, shown in Figure 2 of Appendix A of this chapter, the conditions specified in this section must be investigated assuming the following attitudes:

(1) An attitude in which the main wheels are assumed to contact the ground with the nose wheel just clear of the ground; and

(2) If reasonably attainable at the specified descent and forward velocities, an attitude in which the nose and main wheels are assumed to contact the ground simultaneously.

(d) In addition to the loading conditions prescribed in paragraph *(a)* of this section, but with maximum vertical ground reactions calculated from paragraph *(a)*, the following apply:

(1) The landing gear and directly affected attaching structure must be designed for the maximum vertical ground reaction combined with an aft acting drag component of not less than 25% of this maximum vertical ground reaction.

(2) The most severe combination of loads that are likely to arise during a lateral drift landing must be taken into account. In absence of a more rational analysis of this condition, the following must be investigated:

(i) A vertical load equal to 75% of the maximum ground reaction of 525.473 must be considered in combination with a drag and side load of 40% and 25% respectively of that vertical load.

(ii) The shock absorber and tire deflections must be assumed to be 75% of the deflection corresponding to the maximum ground reaction of 525.473(a)(2). This load case need not be considered in combination with flat tires.

(3) The combination of vertical and drag components is considered to be acting at the wheel axle centreline.

(Change 525-8)

525.481 *Tail-down Landing Conditions*

(a) In the tail-down attitude, the aeroplane is assumed to contact the ground at forward velocity components, ranging from V_{L1} to V_{L2}, parallel to the ground under the conditions prescribed in 525.473 with:

(1) V_{L1} equal to V_{SO} (TAS) at the appropriate landing weight and in standard sea level conditions; and

(2) V_{L2} equal to V_{SO} (TAS) at the appropriate landing weight and altitudes in a hot-day temperature of 41° F above standard.

(3) The combination of vertical and drag components considered to be acting at the main wheel axle centreline.

(b) For the tail-down landing condition for aeroplanes with tail wheels, the main and tail wheels are assumed to contact the ground simultaneously, in accordance with Figure 3 of Appendix A. Ground reaction conditions on the tail wheel are assumed to act:

(1) Vertically; and

(2) Up and aft through the axle at 45 degrees to the ground line.

(c) For the tail-down landing condition for aeroplanes with nose wheels, the aeroplane is assumed to be at an attitude corresponding to either the stalling angle or the maximum angle allowing clearance with the ground by each part of the aeroplane other than the main wheels, in accordance with Figure 3 of Appendix A, whichever is less.

(Change 525-8)

525.483 *One-gear Landing Conditions*

For the one-gear landing conditions, the aeroplane is assumed to be in the level attitude and to contact the ground on one main landing gear, in accordance with Figure 4 of Appendix A of this chapter. In this attitude:

(a) The ground reactions must be the same as those obtained on that side under 525.479*(d)*(1); and

(b) Each unbalanced external load must be reacted by aeroplane inertia in a rational or conservative manner.

(Change 525-8)

525.485 *Side Load Conditions*

In addition to 525.479(d)(2) the following conditions must be considered:

(a) For the side load condition, the aeroplane is assumed to be in the level attitude with only the main wheels contacting the ground, in accordance with Figure 5 of Appendix A.

(b) Side loads of 0.8 of the vertical reaction (on one side) acting inward and 0.6 of the vertical reaction (on the other side) acting outward must be combined with one-half of the maximum vertical ground reactions obtained in the level landing conditions. These loads are assumed to be applied at the ground contact point and to be resisted by the inertia of the aeroplane. The drag loads may be assumed to be zero.

(Change 525-8)

525.487 *Rebound Landing Condition*

(a) The landing gear and its supporting structure must be investigated for the loads occurring during rebound of the aeroplane from the landing surface.

(b) With the landing gear fully extended and not in contact with the ground, a load factor of 20.0 must act on the unsprung weights of the landing gear. This load factor must act in the direction of motion of the unsprung weights as they reach their limiting positions in extending with relation to the sprung parts of the landing gear.

525.489 *Ground Handling Conditions*

Unless otherwise prescribed, the landing gear and aeroplane structure must be investigated for the conditions in 525.491 through 525.509 with the aeroplane at the design ramp weight (the maximum weight for ground handling conditions). No wing lift may be considered. The shock absorbers and tires may be assumed to be in their static position.

525.491 *Taxi, Take-off and Landing Roll*

Within the range of appropriate ground speeds and approved weights, the aeroplane structure and landing gear are assumed to be subjected to loads not less than those obtained when the aircraft is operating over the roughest ground that may reasonably be expected in normal operation.

(Change 525-8)

525.493 *Braked Roll Conditions*

(a) An aeroplane with a tail wheel is assumed to be in the level attitude with the load on the main wheels, in accordance with Figure 6 of Appendix A. The limit vertical load factor is 1.2 at the design landing weight, and 1.0 at the design ramp weight. A drag reaction equal to the vertical reaction multiplied by a coefficient of friction of 0.8, must be combined with the vertical ground reaction and applied at the ground contact point.

(b) For an aeroplane with a nose wheel, the limit vertical load factor is 1.2 at the design landing weight, and 1.0 at the design ramp weight. A drag reaction equal to the vertical reaction, multiplied by a coefficient of friction of 0.8, must be combined with the vertical reaction and applied at the ground contact point of each wheel with brakes. The following two attitudes, in accordance with Figure 6 of Appendix A, must be considered:

(1) The level attitude with the wheels contacting the ground and the loads distributed between the main and nose gear. Zero pitching acceleration is assumed.

(2) The level attitude with only the main gear contacting the ground and with the pitching moment resisted by angular acceleration.

(c) A drag reaction lower than that prescribed in this section may be used if it is substantiated that an effective drag force of 0.8 times the vertical reaction cannot be attained under any likely loading condition.

(d) An aeroplane equipped with a nose gear must be designed to withstand the loads arising from the dynamic pitching motion of the aeroplane due to sudden application of maximum braking force. The aeroplane is considered to be at design take-off weight with the nose and main gears in contact with the ground, and with a steady-state vertical load factor of 1.0. The steady-state nose gear reaction must be combined with the maximum incremental nose gear vertical reaction caused by the sudden application of maximum braking force as described in paragraphs *(b)* and *(c)* of this section.

(e) In the absence of a more rational analysis, the nose gear vertical reaction prescribed in paragraph *(d)* of this section must be calculated according to the following formula:

$$V_N = \frac{W_T}{A+B}\left[B + \frac{f\mu AE}{A+B+\mu E}\right]$$

Where:

V_N = Nose gear vertical reaction.

W_T = Design take-off weight.

A = Horizontal distance between the c.g. of the aeroplane and the nose wheel.

B = Horizontal distance between the c.g. of the aeroplane and the line joining the centres of the main wheels.

E = Vertical height of the c.g. of the aeroplane above the ground in the 1.0 g static condition.

μ = Coefficient of friction of 0.80.

f = Dynamic response factor; 2.0 is to be used unless a lower factor is substantiated. In the absence of other information, the dynamic response factor f may be defined by the equation:

$$f = 1 + \exp\left(\frac{-\pi\xi}{\sqrt{1-\xi^2}}\right)$$

Where:

ξ = is the effective critical damping ratio of the rigid body pitching mode about the main landing gear effective ground contact point.

(Change 525-8)

525.495 *Turning*

In the static position, in accordance with Figure 7 of Appendix A, the aeroplane is assumed to execute a steady turn by nose gear steering, or by application of sufficient differential power, so that the limit load factors applied at the centre of gravity are 1.0 vertically and 0.5 laterally. The side ground reaction of each wheel must be 0.5 of the vertical reaction.

525.497 *Tail-wheel Yawing*

(a) A vertical ground reaction equal to the static load on the tail wheel, in combination with a side component of equal magnitude, is assumed.

(b) If there is a swivel, the tail wheel is assumed to be swivelled 90° to the aeroplane longitudinal axis with the resultant load passing through the axle.

(c) If there is a lock, steering device, or shimmy damper the tail wheel is also assumed to be in the trailing position with the side load acting at the ground contact point.

525.499 *Nose-wheel Yaw and Steering*

(a) A vertical load factor of 1.0 at the aeroplane centre of gravity, and a side component at the nose wheel ground contact equal to 0.8 of the vertical ground reaction at that point are assumed.

(b) With the aeroplane assumed to be in static equilibrium with the loads resulting from the use of brakes on one side of the main landing gear, the nose gear, its attaching structure, and the fuselage structure forward of the centre of gravity must be designed for the following loads:

(1) A vertical load factor at the centre of gravity of 1.0.

(2) A forward acting load at the aeroplane centre of gravity of 0.8 times the vertical load on one main gear.

(3) Side and vertical loads at the ground contact point on the nose gear that are required for static equilibrium.

(4) A side load factor at the aeroplane centre of gravity of zero.

(c) If the loads prescribed in paragraph *(b)* of this section result in a nose gear side load higher than 0.8 times the vertical nose gear load, the design nose gear side load may be limited to 0.8 times the vertical load, with unbalanced yawing moments assumed to be resisted by aeroplane inertia forces.

(d) For other than the nose gear, its attaching structure, and the forward fuselage structure the loading conditions are those prescribed in paragraph *(b)* of this section, except that:

(1) A lower drag reaction may be used if an effective drag force of 0.8 times the vertical reaction cannot be reached under any likely loading condition; and

(2) The forward acting load at the centre of gravity need not exceed the maximum drag reaction on one main gear, determined in accordance with 525.493(b).

(e) With the aeroplane at design ramp weight, and the nose gear in any steerable position, the combined application of full normal steering torque and vertical force equal to 1.33 times the maximum static reaction on the nose gear must be considered in designing the nose gear, its attaching structure, and the forward fuselage structure.

(Change 525-8)

525.503 *Pivoting*

(a) The aeroplane is assumed to pivot about one side of the main gear with the brakes on that side locked. The limit vertical load factor must be 1.0 and the coefficient of friction 0.8.

(b) The aeroplane is assumed to be in static equilibrium, with the loads being applied at the ground contact points, in accordance with Figure 8 of Appendix A.

525.507 *Reversed Braking*

(a) The aeroplane must be in a three point static ground attitude. Horizontal reactions parallel to the ground and directed forward must be applied at the ground contact point of each wheel with brakes. The limit loads must be equal to 0.55 times the vertical load at each wheel

or to the load developed by 1.2 times the nominal maximum static brake torque, whichever is less.

(b) For aeroplanes with nose wheels, the pitching moment must be balanced by rotational inertia.

(c) For aeroplanes with tail wheels, the resultant of the ground reactions must pass through the centre of gravity of the aeroplane.

525.509 *Towing Loads*

(a) The towing loads specified in paragraph *(d)* of this section must be considered separately. These loads must be applied at the towing fittings and must act parallel to the ground. In addition:

(1) A vertical load factor equal to 1.0 must be considered acting at the centre of gravity;

(2) The shock struts and tires must be in their static positions; and

(3) With W_T as the design ramp weight, the towing load, F_{TOW}, is:

(i) 0.3 W_T for W_T less than 30,000 pounds;

(ii) (6 W_T + 450,000)/7 for W_T between 30,000 and 100,000 pounds; and

(iii) 0.15 W_T for W_T over 100,000 pounds.

(b) For towing points not on the landing gear but near the plane of symmetry of the aeroplane, the drag and side tow load components specified for the auxiliary gear apply. For towing points located outboard of the main gear, the drag and side tow load components specified for the main gear apply. Where the specified angle of swivel cannot be reached, the maximum obtainable angle must be used.

(c) The towing loads specified in paragraph *(d)* of this section must be reacted as follows:

(1) The side component of the towing load at the main gear must be reacted by a side force at the static ground line of the wheel to which the load is applied.

(2) The towing loads at the auxiliary gear and the drag components of the towing loads at the main gear must be reacted as follows:

(i) A reaction with a maximum value equal to the vertical reaction must be applied at the axle of the wheel to which the load is applied. Enough aeroplane inertia to achieve equilibrium must be applied.

(ii) The loads must be reacted by aeroplane inertia.

(d) The prescribed towing loads are as follows:

Tow point	Position		Load	
		Magnitude	No.	Direction
Main gear		0.75 F_{TOW} per main gear unit	1	Forward, parallel to drag axis.
			2	Forward, at 30° to drag axis

Tow point	Position		Load	
		Magnitude	No.	Direction
			3	Aft, parallel to drag axis.
			4	Aft, at 30° to drag axis.
Auxiliary gear	Swivelled forward.	1.0 F_{TOW}	5	Forward.
			6	Aft.
	Swivelled aft.	do	7	Forward.
			8	Aft.
	Swivelled 45° from forward.	0.5 F_{TOW}	9	Forward, in plane of wheel.
			10	Aft, in plane of wheel.
	Swivelled 45° from aft.	do	11	Forward, in plane of wheel.
			12	Aft, in plane of wheel.

(Change 525-4 (92-08-01)

525.511 *Ground Load: Unsymmetrical Loads on Multiple-Wheel Units*

(a) General. Multiple-wheel landing gear units are assumed to be subjected to the limit ground loads prescribed in this subchapter under paragraphs *(b)* through *(f)* of this section. In addition:

(1) A tandem strut gear arrangement is a multiple-wheel unit; and

(2) In determining the total load on a gear unit with respect to the provisions of paragraphs (b) through (f) of this section, the transverse shift in the load centroid, due to unsymmetrical load distribution on the wheels, may be neglected.

(b) Distribution of limit loads to wheels; tires inflated. The distribution of the limit loads among the wheels of the landing gear must be established for each landing, taxiing, and ground handling condition, taking into account the effects of the following factors:

(1) The number of wheels and their physical arrangements. For truck type landing gear units, the effects of any see-saw motion of the truck during the landing impact must be considered in determining the maximum design loads for the fore and aft wheel pairs.

(2) Any differentials in tire diameters resulting from a combination of manufacturing tolerances, tire growth, and tire wear. A maximum tire-diameter differential equal to 2/3 of the most unfavourable combination of diameter variations that is obtained when taking into account manufacturing tolerances, tire growth, and tire wear, may be assumed.

(3) Any unequal tire inflation pressure, assuming the maximum variation to be ± 5 percent of the nominal tire inflation pressure.

(4) A runway crown of zero and a runway crown having a convex upward shape that may be approximated by a slope of 1½ percent with the horizontal. Runway crown effects must be considered with the nose gear unit on either slope of the crown.

(5) The aeroplane attitude.

(6) Any structural deflections.

(c) Deflated tires. The effect of deflated tires on the structure must be considered with respect to the loading conditions specified in paragraphs *(d)* through *(f)* of this section, taking into account the physical arrangement of the gear components. In addition:

(1) The deflation of any one tire for each multiple wheel landing gear unit, and the deflation of any two critical tires for each landing gear unit using four or more wheels per unit, must be considered; and

(2) The ground reactions must be applied to the wheels with inflated tires except that, for multiple-wheel gear units with more than one shock strut, a rational distribution of the ground reactions between the deflated and inflated tires, accounting for the differences in shock strut extensions resulting from a deflated tire, may be used.

(d) Landing conditions. For one and for two deflated tires, the applied load to each gear unit is assumed to be 60 percent and 50 percent, respectively, of the limit load applied to each gear for each of the prescribed landing conditions. However, for the drift landing condition of 525.485, 100 percent of the vertical load must be applied.

(e) Taxiing and ground handling conditions. For one and for two deflated tires:

(1) The applied side or drag load factor, or both factors, at the centre of gravity must be the most critical value up to 50 percent and 40 percent, respectively, of the limit side or drag load factors, or both factors, corresponding to the most severe condition resulting from the consideration of the prescribed taxiing and ground handling conditions;

(2) For the braked roll conditions of 525.493(a) and (b)(2), the drag loads on each inflated tire may not be less than those at each tire for the symmetrical load distribution with no deflated tires;

(3) The vertical load factor at the centre of gravity must be 60 percent and 50 percent, respectively, of the factor with no deflated tires, except that it may not be less that 1g; and

(4) Pivoting need not be considered.

(f) Towing conditions. For one and for two deflated tires, the towing load, F_{TOW}, must be 60 percent and 50 percent, respectively, of the load prescribed.

525.519 *Jacking and Tie-down Provisions*

(a) General. The aeroplane must be designed to withstand the limit load conditions resulting from the static ground load conditions of paragraph *(b)* of this section and, if applicable, paragraph *(c)* of this section at the most critical combinations of aeroplane weight and centre of gravity. The maximum allowable load at each jack pad must be specified.

(b) Jacking. The aeroplane must have provisions for jacking and must withstand the following limit loads when the aeroplane is supported on jacks:

(1) For jacking by the landing gear at the maximum ramp weight of the aeroplane, the aeroplane structure must be designed for a vertical load of 1.33 times the vertical static reaction at each jacking point acting singly and in combination with a horizontal load of 0.33 times the vertical static reaction applied in any direction.

(2) For jacking by other aeroplane structure at maximum approved jacking weight:

(i) The aeroplane structure must be designed for a vertical load of 1.33 times the vertical reaction at each jacking point acting singly and in combination with a horizontal load of 0.33 times the vertical static reaction applied in any direction.

(ii) The jacking pads and local structure must be designed for a vertical load of 2.0 times the vertical static reaction at each jacking point, acting singly and in combination with a horizontal load of 0.33 times the vertical static reaction applied in any direction.

(c) Tie-down. If tie-down points are provided, the main tie-down points and local structure must withstand the limit loads resulting from a 65-knot horizontal wind from any direction.

(Change 525-7 (96-09-30))

Water Loads

525.521 *General*

(a) Seaplanes must be designed for the water loads developed during take-off and landing, with the seaplane in any attitude likely to occur in normal operation, and at the appropriate forward and sinking velocities under the most severe sea conditions likely to be encountered.

(b) Unless a more rational analysis of the water loads is made, or the standards in ANC-3 are used, 525.523 through 525.537 apply.

(c) The requirements of this section and 525.523 through 525.537 apply also to amphibians.

525.523 *Design Weights and Centre of Gravity Positions*

(a) Design weights. The water load requirements must be met at each operating weight up to the design landing weight except, that, for the take-off condition prescribed in 525.531, the design water take-off weight (the maximum weight for water taxi and take-off run) must be used.

(b) Centre of gravity positions. The critical centres of gravity within the limits for which certification is requested must be considered to reach maximum design loads for each part of the seaplane structure.

525.525 *Application of Loads*

(a) Unless otherwise prescribed, the seaplane as a whole is assumed to be subjected to the loads corresponding to the load factors specified in 525.527.

(b) In applying the loads resulting from the load factors prescribed in 525.527, the loads may be distributed over the hull or main float bottom (in order to avoid excessive local shear loads and bending moments at the location of water load application) using pressures not less than those prescribed in 525.533*(b)*.

(c) For twin float seaplanes, each float must be treated as an equivalent hull on a fictitious seaplane with a weight equal to one-half the weight of the twin float seaplane.

(d) Except in the take-off condition of 525.531, the aerodynamic lift on the seaplane during the impact is assumed to be 2/3 of the weight of the seaplane.

525.527 *Hull and Main Float Load Factors*

(a) Water reaction load factors n_w must be computed in the following manner:

(1) For the step landing case

$$n_w = \frac{C_1 V_{so}^{\,2}}{(\tan \beta)^{2/3} W^{1/3}}$$

(2) For the bow and stern landing cases

$$\left(n_w = \frac{C_1 V_{so}^{\,2}}{(\tan \beta)^{2/3} m^{1/3}} \times \frac{K_1}{(1 + r_x^{\,2})^{2/3}} \right)$$

(b) The following values are used:

(1) n_w = water reaction load factor (that is, the water reaction divided by seaplane weight).

(2) C_1 = empirical seaplane operations factor equal to 0.012 (except that this factor may not be less than that necessary to obtain the minimum value of step load factor of 2.33).

(3) V_{so} = seaplane stalling speed in knots with flaps extended in the appropriate landing position and with no slipstream effect.

(4) β = angle of dead rise at the longitudinal station at which the load factor is being determined, in accordance with Figure 1 of Appendix B.

(5) W = seaplane design landing weight in pounds.

(6) K_1 = empirical hull station weighing factor, in accordance with Figure 2 of Appendix B.

(7) r_x = ratio of distance, measured parallel to hull reference axis, from the centre of gravity of the seaplane to the hull longitudinal station at which the load factor is being computed to the radius of gyration in pitch of the seaplane, the hull reference axis being a straight line, in the plane of symmetry, tangential to the keel at the main step.

(c) For a twin float seaplane, because of the effect of flexibility of the attachment of the floats to the seaplane, the factor K_1 may be reduced at the bow and stern to 0.8 of the value shown in Figure 2 of Appendix B. This reduction applies only to the design of the carry through and seaplane structure.

525.529 *Hull and Main Float Landing Conditions*

(a) Symmetrical step, bow and stern landing. For symmetrical step, bow, and stern landings, the limit water reaction load factors are those computed under 525.527. In addition:

(1) For symmetrical step landings, the resultant water load must be applied at the keel, through the centre of gravity, and must be directed perpendicularly to the keel line;

(2) For symmetrical bow landings, the resultant water load must be applied to the keel, one-fifth of the longitudinal distance from the bow to the step, and must be directed perpendicularly to the keel line; and

(3) For symmetrical stern landings, the resultant water load must be applied at the keel, at a point 85 percent of the longitudinal distance from the step to the stern post, and must be directed perpendicularly to the keel line.

(b) Unsymmetrical landing for hull and single float seaplanes. Unsymmetrical step, bow and stern landing conditions must be investigated. In addition:

(1) The loading for each condition consists of an upward component and a side component equal, respectively to 0.75 and 0.25 tan β times the resultant load in the corresponding symmetrical landing condition; and

(2) The point of application and direction of the upward component of the load is the same as that in the symmetrical condition, and the point of application of the side component is at the same longitudinal station as the upward component but is directed inward perpendicularly to the plane of symmetry at a point midway between the keel and chine lines.

(c) Unsymmetrical landing; twin float seaplanes. The unsymmetrical loading consists of an upward load at the step of each float of 0.75 at and a side load of 0.25 tan β at one float times the step landing load reached under 525.527. The side load is directed inboard, perpendicularly to the plane of symmetry midway between the keel and chine lines of the float, at the same longitudinal station as the upward load.

525.531 *Hull and Main Float Take-off Conditions*

For the wing and its attachment to the hull or main float:

(a) The aerodynamic wing lift is assumed to be zero; and

(b) A downward inertia load, corresponding to a load factor computed from the following formula, must be applied.

$$n = \frac{C_{TO} \, V_{S1}^{2}}{(\tan^{2/3} \beta) \; W^{1/3}}$$

where:

n = inertia load factor;

C_{TO} = empirical seaplane operations factor equal to 0.004;

V_{S1} = seaplane stalling speed (knots) at the design take-off weight with the flaps extended in the appropriate take-off position;

β = angle of dead rise at the main step (degrees); and

W = design water take-off weight in pounds.

525.533 *Hull and Main Float Bottom Pressures*

(a) General. The hull and main float structure, including frames and bulkheads, stringers, and bottom plating, must be designed under this section.

(b) Local pressures. For the design of the bottom plating and stringers and their attachments to the supporting structure, the following pressure distributions must be applied:

(1) For an unflared bottom, the pressure at the chine is 0.75 times the pressure at the keel, and the pressures between the keel and chine vary linearly, in accordance with Figure 3 of Appendix B. The pressure at the keel (p.s.i.) is computed as follows:

$$P_k = C_2 \text{ x } \frac{K_2 V_{S1}^2}{\tan \beta_k}$$

where:

P_K = pressure (p.s.i.) at the keel;

C_2 = 0.00213;

K_2 = hull station weighing factor, in accordance with Figure 2 of Appendix B;

V_{S1} = seaplane stalling speed (knots) at the design water take-off weight with flaps extended in the appropriate take-off position; and

β_k = angle of dead rise at keel, in accordance with Figure 1 of Appendix B.

(2) For a flared bottom, the pressure at the beginning of the flare is the same as that for an unflared bottom, and the pressure between the chine and the beginning of the flare varies linearly, in accordance with Figure 3 of Appendix B. The pressure distribution is the same as that prescribed in subparagraph (1) of this paragraph for an unflared bottom except that the pressure at the chine is computed as follows:

$$P_{ch} = C_3 \text{ x } \frac{K_2 V_{S1}^2}{\tan \beta}$$

where:

P_{ch} = pressure (p.s.i.) at the chine;

C_3 = 0.0016;

K_2 = hull station weighting factor, in accordance with Figure 2 of Appendix B;

V_{S1} = seaplane stalling speed (knots) at the design water take-off weight with flaps extended in the appropriate take-off position; and

ß = angle of dead rise at appropriate station.

The area over which these pressures are applied must simulate pressures occurring during high localised impacts on the hull or float, but need not extend over an area that would induce critical stresses in the frames or in the overall structure.

(c) Distributed pressures. For the design of the frames, keel, and chine structure, the following pressure distributions apply:

(1) Symmetrical pressures are computed as follows:

$$P = C_4 \times \frac{K_2 V_{SO}^2}{\tan \beta}$$

where:

P = pressure (p.s.i.);

$C_4 = 0.078\ C_1$ (with C_1 computed under 525.527);

K_2 = hull station weighting factor, determined in accordance with Figure 2 of Appendix B;

V_{S0} = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect; and

β = angle of dead rise at appropriate station.

(2) The unsymmetrical pressure distribution consists of the pressures prescribed in subparagraph (1) of this paragraph on one side of the hull or main float centreline and one-half of that pressure on the other side of the hull or main float centreline, in accordance with Figure 3 of Appendix B.

These pressures are uniform and must be applied simultaneously over the entire hull or main float bottom. The loads obtained must be carried into the sidewall structure of the hull proper, but need not be transmitted in a fore and aft direction as shear and bending loads.

525.535 *Auxiliary Float Loads*

(a) General. Auxiliary floats and their attachments and supporting structures must be designed for the conditions prescribed in this section. In the cases specified in paragraphs *(b)* through *(e)* of this section, the prescribed water loads may be distributed over the float bottom to avoid excessive local loads, using bottom pressures not less than those prescribed in paragraph *(g)* of this section.

(b) Step Loading. The resultant water load must be applied in the plane of symmetry of the float at a point three-fourths of the distance from the bow to the step and must be perpendicular to the keel. The resultant limit load is computed as follows, except that the value of L need not exceed three times the weight of the displaced water when the float is completely submerged:

$$L = \frac{C_5 V_{SO}^2 W^{2/3}}{(\tan^{2/3} \beta_s)(1 + r_y^2)^{2/3}}$$

where:

L = limit load (lbs.);

$C_5 = 0.0053$;

V_{S0} = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect;

W = seaplane design landing weight in pounds;

β_S = angle of dead rise at a station 3/4 of the distance from the bow to the step, but need not be less than 15 degrees; and

r_y = ratio of the lateral distance between the centre of gravity and the plane of symmetry of the float to the radius of gyration in roll.

(c) Bow loading. The resultant limit load must be applied in the plane of symmetry of the float at a point one-fourth of the distance from the bow to the step and must be perpendicular to the tangent to the keel line at that point. The magnitude of the resultant load is that specified in paragraph *(b)* of this section.

(d) Unsymmetrical step loading. The resultant water loads consists of a component equal to 0.75 times the load specified in paragraph *(a)* of this section and a side component equal to 0.25 *tan* times the load specified in paragraph *(b)* of this section. The side load must be applied perpendicularly to the plane of symmetry of the float at a point midway between the keel and the chine.

(e) Unsymmetrical bow loading. The resultant water load consists of a component equal to 0.75 times the load specified in paragraph *(b)* of this section and a side component equal to 0.25 *tan* β times the load specified in paragraph *(c)* of this section. The side load must be applied perpendicularly to the plane of symmetry at a point midway between the keel and the chine.

(f) Immersed float condition. The resultant load must be applied at the centroid of the cross section of the float at a point one-third of the distance from the bow to the step. The limit load components are as follows:

vertical = pgV

$$\text{aft} = C_x \frac{\rho}{2} V^{2/3} (KV_{so})^2$$

$$\text{side} = C_x \frac{\rho}{2} V^{2/3} (KV_{so})^2$$

where:

ρ = mass density of water (slugs/ft.^{3};

V = volume of float (ft.^{3});

C_x = coefficient of drag force, equal to 0.133;

C_y = coefficient of side force, equal to 0.106;

K = 0.8, except that lower values may be used if it is shown that the floats are incapable of submerging at a speed of 0.8 V_{S0} in normal operations;

V_{S0} = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect; and

g = acceleration due to gravity (ft./sec.^{2}).

(g) Float bottom pressures. The float bottom pressures must be established under 525.533, except that the value of K_2 in the formulae may be taken as 1.0. The angle of dead rise to be used in determining the float bottom pressures is set forth in paragraph *(b)* of this section.

525.537 *Sea-wing Loads*

Sea-wing design loads must be based on applicable test data.

Emergency Landing Conditions

525.561 *General*

(a) The aeroplane, although it may be damaged in emergency landing conditions on land or water, must be designed as prescribed in this section to protect each occupant under those conditions.

(b) The structure must be designed to give each occupant every reasonable chance of escaping serious injury in a minor crash landing when:

(1) Proper use is made of seats, belts, and all other safety design provisions;

(2) The wheels are retracted (where applicable); and

(3) The occupant experiences the following ultimate inertia forces acting separately relative to the surrounding structure:

(i) Upward 3.0g.

(ii) Forward 9.0g.

(iii) Sideward, 3.0g on the airframe; and 4.0g on the seats and their attachments.

(iv) Downward, 6.0g.

(v) Rearward, 1.5g.

(c) For equipment, cargo in the passenger compartments and any other large masses, the following apply:

(1) Except as provided in paragraph (c)(2) of this section, these items must be positioned so that if they break loose they will be unlikely to:

(i) Cause direct injury to occupants;

(ii) Penetrate fuel tanks or lines or cause fire or explosion hazard by damage to adjacent systems; or

(iii) Nullify any of the escape facilities provided for use after an emergency landing.

(2) When such positioning is not practical (e.g. fuselage mounted engines or auxiliary power units) each such item of mass shall be restrained under all loads up to those specified in paragraph (b)(3) of this section. The local attachments for these items should be designed to withstand 1.33 times the specified loads if these items are subject to severe wear and tear through frequent removal (e.g. quick change interior items).

(d) Seats and items of mass (and their supporting structure) must not deform under any loads up to those specified in paragraph *(b)*(3) of this section in any manner that would impede subsequent rapid evacuation of occupants.

(Change 525-2 (89-01-01))
(Change 525-8)

525.562 *Emergency Landing Dynamic Conditions*

(a) The seat and restraint system in the aeroplane must be designed as prescribed in this section to protect each occupant during an emergency landing condition when:

(1) Proper use is made of seats, safety belts, and shoulder harnesses provided for in the design; and

(2) The occupant is exposed to loads resulting from the conditions prescribed in this section.

(b) Each seat type design approved for crew or passenger occupancy during take-off and landing must successfully complete dynamic tests or be demonstrated by rational analysis based on dynamic tests of a similar type seat, in accordance with each of the following emergency landing conditions. The tests must be conducted with an occupant simulated by a 170-pound anthropomorphic test dummy, as defined by the USA 49 CFR Part 372, Subpart B, or its equivalent, sitting in the normal upright position.

(1) A change in downward vertical velocity (Δv) of not less than 35 feet per second, with the aeroplane's longitudinal axis canted downward 30 degrees with respect to the horizontal plane and with the wings level. Peak floor deceleration must occur in not more than 0.08 seconds after impact and must reach a minimum of 14g.

(2) A change in forward longitudinal velocity (Δv) of not less than 44 feet per second, with the aeroplane's longitudinal axis horizontal and yawed 10 degrees either right or left, whichever would cause the greatest likelihood of the upper torso restraint system (where installed) moving off the occupant's shoulder, and with the wings level. Peak floor deceleration must occur in not more than 0.09 seconds after impact and must reach a minimum of 16g. Where floor rails or floor fittings are used to attach the seating devices to the test fixture, the rails or fittings must be misaligned with respect to the adjacent set of rails or fittings by at least 10 degrees vertically (i.e., out of Parallel) with one rolled 10 degrees.

(c) The following performance measures must not be exceeded during the dynamic tests conducted in accordance with paragraph *(b)* of this section:

(1) Where upper torso straps are used for crew members, tension loads in individual straps must not exceed 1,750 pounds. If dual straps are used for restraining the upper torso, the total strap tension loads must not exceed 2,000 pounds.

(2) The maximum compressive load measured between the pelvis and the lumbar column of the anthropomorphic dummy must not exceed 1,500 pounds.

(3) The upper torso restraint straps (where installed) must remain on the occupant's shoulder during the impact.

(4) The lap safety belt must remain on the occupant's pelvis during the impact.

(5) Each occupant must be protected from serious head injury under the conditions prescribed in paragraph (b) of this section. Where head contact with seats or other structure can occur, protection must be provided so that the head impact does not exceed a Head Injury Criterion (HIC) of 1,000 units. The level of HIC is defined by the equation:

$$HIC = \left\{ (t_2 - t_1) \left[\frac{1}{(t_2 - t_1)} \int_{t_1}^{t_2} a(t)dt \right]^{2.5} \right\}_{max}$$

Where:

t_1 is the initial integration time,

t_2 is the final integration time, and

a(t) is the total acceleration vs. time curve for the head strike, and where:

(t) is in seconds, and (a) is in units of gravity (g).

(6) Where leg injuries may result from contact with seats or other structure, protection must be provided to prevent axially compressive loads exceeding 2,250 pounds in each femur.

(7) The seat must remain attached at all points of attachment, although the structure may have yielded.

(8) Seats must not yield under the tests specified in paragraphs (b)(1) and (b)(2) of this section to the extent they would impede rapid evacuation of the aeroplane occupants.

(Change 525-2 (89-01-01))

525.563 *Structural Ditching Provisions*

Structural strength considerations of ditching provisions must be in accordance with 525.801(e).

Fatigue Evaluation

525.571 *Damage-tolerance and Fatigue Evaluation of Structure*

(a) General. An evaluation of the strength, detail design, and fabrication must show that catastrophic failure due to fatigue, corrosion, manufacturing defects, or accidental damage, will be avoided throughout the operational life of the aeroplane. This evaluation must be conducted in accordance with the provisions of paragraphs *(b)* and *(e)* of this section, except as specified in paragraph *(c)* of this section, for each part of the structure that could contribute to a catastrophic failure (such as wing, empennage, control surfaces and their systems, the fuselage, engine mounting, landing gear, and their related primary attachments). For turbojet powered aeroplanes, those parts that could contribute to a catastrophic failure must also be evaluated under paragraph *(d)* of this section. In addition, the following apply:

(1) Each evaluation required by this section must include:

(i) The typical loading spectra, temperatures, and humidities expected in services;

(ii) The identification of principal structural elements and detail design points, the failure of which could cause catastrophic failure of the aeroplane; and

(iii) An analysis, supported by test evidence, of the principal structural elements and detail design points identified in paragraph (a)(1)(ii) of this section.

(2) The service history of aeroplanes of similar structural design, taking due account of differences in operating conditions and procedures, may be used in the evaluations required by this section.

(3) Based on the evaluations required by this section, inspections or other procedures must be established, as necessary, to prevent catastrophic failure, and must be included in the Airworthiness Limitations section of the Instructions for Continued Airworthiness required by 525.1529. The limit of validity of the engineering data that supports the structural maintenance program (hereafter referred to as LOV), stated as a number of total accumulated flight cycles or flight hours or both, established by this section must also be included in the Airworthiness Limitations section of the Instructions for Continued Airworthiness required by 525.1529. Inspection thresholds for the following types of structure must be established based on crack growth analyses and/or test, assuming the structure contains an initial flaw of the maximum probable size that could exist as a result of manufacturing or service-induced damage:
(amended 2012/03/27)

(i) Single load path structure, and

(ii) Multiple load path "fail-safe" structure and crack arrest "fail-safe" structure, where it cannot be demonstrated that load path failure, partial failure, or crack arrest will be detected and repaired during normal ,maintenance, inspection, or operation of an aeroplane prior to failure of the remaining structure.

(b) Damage-tolerance evaluation. The evaluation must include a determination of the probable locations and modes of damage due to fatigue, corrosion, or accidental damage. Repeated load and static analyses supported by test evidence and (if available) service experience must also be incorporated in the evaluation. Special consideration for widespread fatigue damage must be included where the design is such that this type of damage could occur. An LOV must be established that corresponds to the period of time, stated as a number of total accumulated flight cycles or flight hours or both, during which it is demonstrated that widespread fatigue damage will not occur in the aeroplane structure. This demonstration must be by full-scale fatigue test evidence. The type certificate may be issued prior to completion of the full-scale fatigue testing, provided the Minister has approved a plan for completing the required tests, and the Airworthiness Limitations section of the Instructions for Continued Airworthiness required by 525.1529 of this chapter specifies that no aeroplane may be operated beyond a number of cycles equal to ½ the number of cycles accumulated on the fatigue test article, until such testing is completed. The extent of damage for residual strength evaluation at any time within the operational life of the aeroplane must be consistent with the initial detectability and subsequent growth under repeated loads. The residual strength evaluation must show that the remaining structure is able to withstand loads (considered as static ultimate loads) corresponding to the following conditions:
(amended 2012/03/27)

(1) The limit symmetrical manoeuvring conditions specified in 525.337 at all speeds up to V_C and in 525.345.

(2) The limit gust conditions specified in 525.341 at the specified speeds up to V_C, and in 525.345.

(3) The limit rolling conditions specified in 525.349 and the limit unsymmetrical conditions specified in 525.367 and 525.427(a) through (c), at speeds up to V_C.

(4) The limit yaw manoeuvring conditions specified in 525.351(a) at the specified speeds up to V_C.

(5) For pressurised cabins, the following conditions:

(i) The normal operating differential pressure combined with the expected external aerodynamic pressures applied simultaneously with the flight loading conditions specified in paragraphs (b)(1) through (4) of this section, if they have a significant effect.

(ii) The maximum value of normal operating differential pressure (including the expected external aerodynamic pressures during 1g level flight) multiplied by a factor of 1.15, omitting other loads.

(6) For landing gear and directly affected airframe structure, the limit ground loading conditions specified in 525.473, 525.491, and 525.493.

If significant changes in structural stiffness or geometry, or both, follow from a structural failure, or partial failure, the effect on damage tolerance must be further investigated.

(c) Fatigue (safe-life) evaluation. Compliance with the damage-tolerance requirements of paragraph *(b)* of this section is not required if the applicant establishes that their application for particular structure is impractical. This structure must be shown by analysis, supported by test evidence, to be able to withstand the repeated loads of variable magnitude expected during its service life without detectable cracks. Appropriate safe-life scatter factors must be applied.

(d) Sonic fatigue strength. It must be shown by analysis, supported by test evidence, or by the service history of aeroplanes of similar structural design and sonic excitation environment, that:

(1) Sonic fatigue cracks are not probable in any part of the flight structure subject to sonic excitation; or

(2) Catastrophic failure caused by sonic cracks is not probable assuming that the loads prescribed in paragraph (b) of this section are applied to all areas affected by those cracks.

(e) Damage-tolerance (discrete source) evaluation. The aeroplane must be capable of successfully completing a flight during which likely structural damage occurs as a result of:

(1) Impact with a 4-pound bird when the velocity of the aeroplane relative to the bird along the aeroplane's flight path is equal to V_C at sea level or 0.85 V_C at 8,000 feet, whichever is more critical;

(2) Uncontained fan blade impact;

(3) Uncontained engine failure; or

(4) Uncontained high energy rotating machinery failure.

The damaged structure must be able to withstand the static loads (considered as ultimate loads) which are reasonably expected to occur on the flight. Dynamic effects on these static loads need not be considered. Corrective action to be taken by the pilot following the incident, such as limiting manoeuvres, avoiding turbulence, and reducing speed, must be considered. If significant changes in structural stiffness or geometry, or both, follow from a structural failure or partial failure, the effect on damage tolerance must be further investigated.

(Change 525-1 (87-01-01))
(Change 525-2 (89-01-01))
(Change 525-3 (91-11-01))
(Change 525-8)

525.573 *(Reserved)*

Lightning Protection

525.581 *Lightning Protection*

(a) The aeroplane must be protected against catastrophic effects from lightning.

(b) For metallic components, compliance with paragraph *(a)* of this section may be shown by:

(1) Bonding the components properly to the airframe; or

(2) Designing the components so that a strike will not endanger the aeroplane.

(c) For non-metallic components, compliance with paragraph *(a)* of this section may be shown by:

(1) Designing the components to minimise the effect of a strike; or

(2) Incorporating acceptable means of diverting the resulting electrical current so as not to endanger the aeroplane.

SUBCHAPTER D

Design and Construction

525.601 *General*

The aeroplane may not have design features or details that experience has shown to be hazardous or unreliable. The suitability of each questionable design detail and part must be established by tests.

525.603 *Materials*

The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must:

(a) Be established on the basis of experience or tests;

(b) Conform to approved specifications (such as industry or military specifications, or Technical Standard Orders) that ensure their having the strength and other properties assumed in the design data; and

(c) Take into account the effects of environmental conditions, such as temperature and humidity, expected in service.

525.605 *Fabrication Methods*

(a) The methods of fabrication used must produce a consistently sound structure. If a fabrication process (such as gluing, spot welding, or heat treating) requires close control to reach this objective, the process must be performed under an approved process specification.

(b) Each new aircraft fabrication method must be substantiated by a test program.

525.607 *Fasteners*

(a) Each removable bolt, screw, nut, pin, or other removable fastener must incorporate two separate locking devices if:

(1) Its loss could preclude continued flight and landing within the design limitations of the aeroplane using normal pilot skill and strength; or

(2) Its loss could result in the reduction in pitch, yaw, or roll control capability or response below that required by subchapter B of this chapter.

(b) The fasteners specified in paragraph (1) of this section and their locking devices may not be adversely affected by the environmental conditions associated with the particular installation.

(c) No self-locking nut may be used on any bolt subject to rotation in operation unless a non-friction locking device is used in addition to the self-locking device.

525.609 *Protection of Structure*

Each part of the structure must:

(a) Be suitably protected against deterioration or loss of strength in service due to any cause, including:

(1) Weathering;

(2) Corrosion; and

(3) Abrasion; and

(b) Have provisions for ventilation and drainage where necessary for protection.

525.611 *Accessibility Provisions*

(a) Means must be provided to allow inspection (including inspection of principal structural elements and control systems), replacement of parts normally requiring replacement, adjustment, and lubrication as necessary for continued airworthiness. The inspection means for each item must be practicable for the inspection interval for the item. Non-destructive inspection aids may be used to inspect structural elements where it is impracticable to provide means for direct visual inspection if it is shown that the inspection is effective and the inspection procedures are specified in the maintenance manual required by 525.1529. (amended 2009/05/11)

(b) EWIS must meet the accessibility requirements of 525.1719. (amended 2009/05/11)

525.613 *Material Strength Properties and Material Design Values*
(amended 2003/11/26)

(a) Material strength properties shall be based on enough tests of material meeting approved specifications to establish design values on a statistical basis.
(amended 2003/11/26)

(b) Material design values shall be chosen to minimise the probability of structural failures due to material variability. Except as provided in paragraph *(e)* and *(f)* of this section, compliance with this paragraph shall be demonstrated by selecting material design values which assure material strength with the following probability:
(amended 2003/11/26)

(1) Where applied loads are eventually distributed through a single member within an assembly, the failure of which would result in loss of structural integrity of the component, 99 percent probability with 95 percent confidence.

(2) For redundant structure, in which the failure of individual elements would result in applied loads being safely distributed to other load carrying members, 90 percent probability with 95 percent confidence.

(c) The effects of environmental conditions, such as temperature and moisture, on material design values used in an essential component or structure shall be considered where these effects are significant within the aeroplane operating envelope.
(amended 2003/11/26)

(d) Reserved
(amended 2003/11/26)

(e) Greater material design values may be used if a "premium selection" of the material is made in which a specimen of each individual item is tested before use to determine that the actual strength properties of that particular item will equal or exceed those used in design.
(amended 2003/11/26)

(f) Other material design values may be used if approved by the Minister.
(amended 2003/11/26)

(Change 525-3 (91-11-01))

525.615 *(Removed)*

(Change 525-3 (91-11-01))

525.619 *Special Factors*

The factor of safety prescribed in 525.303 must be multiplied by the highest pertinent special factor of safety prescribed in 525.621 through 525.625 for each part of the structure whose strength is:

(a) Uncertain;

(b) Likely to deteriorate in service before normal replacement; or

(c) Subject to appreciable variability because of uncertainties in manufacturing processes or inspection methods.

525.621 *Casting Factors*

(a) General. The factors, tests, and inspections specified in paragraphs *(b)* through *(d)* of this section must be applied in addition to those necessary to establish foundry quality control. The inspections must meet approved specifications. Paragraphs *(c)* and *(d)* of this section apply to any structural castings except castings that are pressure tested as parts of hydraulic or other fluid systems and do not support structural loads.

(b) Bearing stresses and surfaces. The casting factors specified in paragraphs *(c)* and *(d)* of this section:

(1) Need not exceed 1.25 with respect to bearing stresses regardless of the method of inspection used; and

(2) Need not be used with respect to the bearing surfaces of a part whose bearing factor is larger than the applicable casting factor.

(c) Critical castings. For each casting whose failure would preclude continued safe flight and landing of the aeroplane or result in serious injury to occupants, the following apply:

(1) Each critical casting must:

(i) Have a casting factor of not less than 1.25; and

(ii) Receive 100 percent inspection by visual, radiographic, and magnetic particle or penetrant inspection methods or approved equivalent non-destructive inspection methods.

(2) For each critical casting with a casting factor less than 1.50, three sample castings must be static tested and shown to meet:

(i) The strength requirements of 525.305 at an ultimate load corresponding to a casting factor of 1.25; and

(ii) The deformation requirements of 525.305 at a load of 1.15 times the limit load.

(3) Examples of these castings are structural attachment fittings, parts of flight control systems, control surface hinges and balance weight attachments, seat, berth, safety belt, and fuel and oil tank supports and attachments, and cabin pressure valves.

(d) Non-critical castings. For each casting other than those specified in paragraph *(c)* of this section, the following apply:

(1) Except as provided in subparagraphs (2) and (3) of this paragraph, the casting factors and corresponding inspections must meet the following table:

Casting factor	Inspection
2.0 or more	100% visual.
Less than 2.0 but more than 1.5	100% visual, and magnetic particle or penetrant or equivalent non-destructive inspection methods.
1.25 through 1.50	100% visual, magnetic particle or penetrant, and radiographic, or approved equivalent non-destructive inspection methods.

(2) The percentage of castings inspected by non-visual methods may be reduced below that specified in subparagraph (1) of this paragraph when an approved quality control procedure is established.

(3) For castings procured to a specification that guarantees the mechanical properties of the material in the casting and provides for demonstration of these properties by test of coupons cut from the castings on a sampling basis:

(i) A casting factor of 1.0 may be used; and

(ii) The castings must be inspected as provided in subparagraph (1) of this paragraph for casting factors of "1.25 through 1.50" and tested under paragraph (c)(2) of this section.

525.623 *Bearing Factors*

(a) Except as provided in paragraph *(b)* of this section, each part that has clearance (free fit), and that is subject to pounding or vibration, must have a bearing factor large enough to provide for the effects of normal relative motion.

(b) No bearing factor need be used for a part for which any larger special factor is prescribed.

525.625 *Fitting Factors*

For each fitting (a part or terminal used to join one structural member to another), the following apply:

(a) For each fitting whose strength is not proven by limit and ultimate load tests in which actual stress conditions are simulated in the fitting and surrounding structures, a fitting factor of at least 1.15 must be applied to each part of:

(1) The fitting;

(2) The means of attachment; and

(3) The bearing on the joined members.

(b) No fitting factor need be used:

(1) For joints made under approved practices and based on comprehensive test data (such as continuous joints in metal plating, welded joints, and scarf joints in wood); or

(2) With respect to any bearing surface for which a larger special factor is used.

(c) For each integral fitting, the part must be treated as a fitting up to the point at which the section properties become typical of the member.

(d) For each seat, berth, safety belt, and harness, the fitting factor specified in 525.785*(f)*(3) applies.

(Change 525-3 (91-11-01))

525.629 *Aeroelastic Stability Requirements*

(a) General. The aeroelastic stability evaluations required under this section include flutter, divergence, control reversal and any undue loss of stability and control as a result of structural

deformation. The aeroelastic evaluation must include whirl modes associated with any propeller or rotating device that contributes significant dynamic forces. Compliance with this section must be shown by analyses, wind tunnel tests, ground vibration tests, flight tests, or other means found necessary by the Minister.

(b) Aeroelastic Stability Envelopes. The aeroplane must be designed to be free from aeroelastic instability for all configurations and design conditions within the aeroelastic stability envelopes as follows:

(1) For normal conditions without failures, malfunctions, or adverse conditions, all combinations of altitudes and speeds encompassed by the V_D/M_D versus altitude envelope enlarged at all points by an increase of 15 percent in equivalent airspeed at both constant Mach number and constant altitude. In addition, a proper margin of stability must exist at all speeds up to V_D/M_D and, there must be no large and rapid reduction in stability as V_D/M_D is approached. The enlarged envelope may be limited to Mach 1.0 when M_D is less than 1.0 at all design altitudes, and

(2) For the conditions described in 525.629(d) below, for all approved altitudes, any airspeed up to the greater airspeed defined by:

(i) The V_D/M_D envelope determined by 525.335(b); or,

(ii) An altitude-airspeed envelope defined by a 15 percent increase in equivalent airspeed above V_C at constant altitude, from sea level to the altitude of the intersection of 1.15 V_C with the extension of the constant cruise Mach number line, M_C, then a linear variation in equivalent airspeed to M_C + .05 at the altitude of the lowest V_C/M_C intersection; then at higher altitudes, up to the maximum flight altitude, the boundary defined by a .05 Mach increase in M_C at constant altitude.

(c) Balance Weights. If concentrated balance weights are used, their effectiveness and strength, including supporting structure, must be substantiated.

(d) Failures, malfunctions, and adverse conditions. The failures, malfunctions, and adverse conditions which must be considered in showing compliance with the section are:

(1) Any critical fuel loading conditions, not shown to be extremely improbable, which may result from mismanagement of fuel.

(2) Any single failure in any flutter damper system.

(3) For aeroplanes not approved for operations in icing conditions, the maximum likely ice accumulation expected as a result of an inadvertent encounter.

(4) Failure of any single element of the structure supporting any engine, independently mounted propeller shaft, large auxiliary power unit, or large externally mounted aerodynamic body (such as an external fuel tank).

(5) For aeroplanes with engines that have propellers or large rotating devices capable of significant dynamic forces, any single failure of the engine structure that would reduce the rigidity of the rotational axis.

(6) The absence of aerodynamic or gyroscopic forces resulting from the most adverse combination of feathered propellers or other rotating devices capable of significant

dynamic forces. In addition, the effect of a single feathered propeller or rotating device must be coupled with the failures of paragraphs (d)(4) and (d)(5) of this section.

(7) Any single propeller or rotating device capable of significant dynamic forces rotating at the highest likely overspeed.

(8) Any damage or failure condition, required or selected for investigation by 525.571. The single structural failures described in paragraphs (d)(4) and (d)(5) of this section need not be considered in showing compliance with this section if:

(i) The structural element could not fail due to discreet source damage resulting from the conditions described in 525.571(e), and

(ii) A damage tolerance investigation in accordance with 525.571(b) shows that the maximum extent of damage assumed for the purpose of residual strength evaluation does not involve complete failure of the structural element.

(9) Any damage, failure, or malfunction considered under 525.631, 525.671, 525.672 and 525.1309.

(10) Any other combination of failures, malfunctions, or adverse conditions not shown to be extremely improbable.

(e) Flight Flutter Testing. Full scale flight flutter tests at speeds up to V_{DF}/M_{DF} must be conducted for new type designs and for modifications to a type design unless the modifications have been shown to have an insignificant effect on the aeroelastic stability. These tests must demonstrate that the aeroplane has a proper margin of damping at all speeds up to V_{DF}/M_{DF} and that there is no large and rapid reduction in damping as V_{DF}/M_{DF} is approached. If a failure, malfunction or adverse condition is simulated during flight test in showing compliance with paragraph *(d)* of this section, the maximum speed investigated need not exceed V_{FC}/M_{FC} if it is shown, by correlation of the flight test data with other test data or analyses, that the aeroplane is free from any aeroelastic instability at all speeds within the altitude-airspeed envelope described in paragraph *(b)*(2) of this section.

(Change 525-3 (91-11-01))
(Change 525-5 (92-10-30))

525.631 *Bird Strike Damage*

The empennage structure must be designed to assure capability of continued safe flight and landing of the aeroplane after impact with an 8 pound bird when the velocity of the aeroplane (relative to the bird along the aeroplane's flight path) is equal to V_C at sea level, selected under 525.335(a). Compliance with this section by provision of redundant structure and protected location of control system elements or protective devices such as splitter plates or energy absorbing material is acceptable. Where compliance is shown by analysis, tests, or both, use of data on aeroplanes having similar structural design is acceptable.

Control Surfaces

525.651 *Proof of Strength*

(a) Limit load tests of control surfaces are required. These tests must include the horn or fitting to which the control system is attached.

(b) Compliance with the special factors requirements of 525.619 through 525.625 and 525.657 for control surface hinges must be shown by analysis or individual load tests.

525.655 *Installation*

(a) Movable tail surfaces must be installed so that there is no interference between any surfaces when one is held in its extreme position and the others are operated through their full angular movement.

(b) If an adjustable stabiliser is used, it must have stops that will limit its range of travel to the maximum for which the aeroplane is shown to meet the trim requirements of 525.161.

525.657 *Hinges*

(a) For control surface hinges, including ball, roller, and self-lubricated bearing hinges, the approved rating of the bearing may not be exceeded. For non-standard bearing hinge configurations, the rating must be established on the basis of experience or tests and, in the absence of a rational investigation, a factor of safety of not less than 6.67 must be used with respect to the ultimate bearing strength of the softest material used as a bearing.

(b) Hinges must have enough strength and rigidity for loads parallel to the hinge line.

Control Systems

525.671 *General*

(a) Each control and control system must operate with the ease, smoothness, and positiveness appropriate to its function.

(b) Each element of each flight control system must be designed, or distinctively and permanently marked, to minimise the probability of incorrect assembly that could result in the malfunctioning of the system.

(c) The aeroplane must be shown by analysis, test, or both, to be capable of continued safe flight and landing after any of the following failures or jamming in the flight control system and surfaces (including trim, lift, drag, and feel systems) within the normal flight envelope, without requiring exceptional piloting skill or strength. Probable malfunctions must have only minor effects on control system operation and must be capable of being readily counteracted by the pilot.

(1) Any single failure, excluding jamming (for example, disconnection or failure of mechanical elements, or structural failure of hydraulic components, such as actuators, control spool housing, and valves).

(2) Any combination of failures not shown to be extremely improbable, excluding jamming (for example, dual electrical or hydraulic system failures, or any single failure in combination with any probable hydraulic or electrical failure).

(3) Any jam in a control position normally encountered during take-off, climb, cruise, normal turns, descent, and landing unless the jam is shown to be extremely improbable, or can be alleviated. A runaway of a flight control to an adverse position and jam must be accounted for if such runaway and subsequent jamming is not extremely improbable.

(d) The aeroplane must be designed so that it is controllable if all engines fail. Compliance with this requirement may be shown by analysis where that method has been shown to be reliable.

525.672 *Stability Augmentation and Automatic and Power-Operated Systems*

If the functioning of stability augmentation or other automatic or power-operated systems is necessary to show compliance with the flight characteristics requirements of this chapter, such systems must comply with 525.671 and the following:

(a) A warning which is clearly distinguishable to the pilot under expected flight conditions without requiring his attention must be provided for any failure in the stability augmentation system or in any other automatic or power-operated system which could result in an unsafe condition if the pilot were not aware of the failure. Warning systems must not activate the control systems.

(b) The design of the stability augmentation system or of any other automatic or power-operated system must permit initial counteraction of failures of the type specified in 525.671*(c)* without requiring exceptional pilot skill or strength, by either the deactivation of the system, or a failed portion thereof, or by overriding the failure by movement of the flight controls in the normal sense.

(c) It must be shown that after any single failure of the stability augmentation system or any other automatic or power-operated system:

(1) The aeroplane is safely controllable when the failure or malfunction occurs at any speed or altitude within the approved operating limitations that is critical for the type of failure being considered;

(2) The controllability and manoeuvrability requirements of this chapter are met within a practical operational flight envelope (for example, speed, altitude, normal acceleration, and aeroplane configurations) which is described in the *Aeroplane Flight Manual*; and

(3) The trim, stability, and stall characteristics are not impaired below a level needed to permit continued flight and landing.

525.673 *(Removed)*

(Change 525-3 (91-11-01))

525.675 *Stops*

(a) Each control system must have stops that positively limit the range of motion of each movable aerodynamic surface controlled by the system.

(b) Each stop must be located so that wear, slackness, or take-up adjustments will not adversely affect the control characteristics of the aeroplane because of a change in the range of surface travel.

(c) Each stop must be able to withstand any loads corresponding to the design conditions for the control system.

525.677 *Trim Systems*

(a) Trim controls shall be designed to prevent inadvertent or abrupt operation and to operate in the plane, and with the sense of motion, of the aeroplane.
(amended 2005/06/03)

(b) There shall be means adjacent to the trim control to indicate the direction of the control movement relative to the aeroplane motion. In addition, there must be clearly visible means to indicate the position of the trim device with respect to the range of adjustment. The indicator shall be clearly marked with the range within which it has been demonstrated that take-off is safe for all centre of gravity positions approved for take-off.
(amended 2005/06/03)

(c) Trim control systems shall be designed to prevent creeping in flight. Trim tab controls shall be irreversible unless the tab is appropriately balanced and shown to be free from flutter.
(amended 2005/06/03)

(d) If an irreversible tab control system is used, the part from the tab to the attachment of the irreversible unit to the aeroplane structure shall consist of a rigid connection.
(amended 2005/06/03)

525.679 *Control System Gust Locks*

(a) There must be a device to prevent damage to the control surfaces (including tabs), and to the control system, from gusts striking the aeroplane while it is on the ground or water. If the device, when engaged, prevents normal operation of the control surface by the pilot, it must:

(1) Automatically disengage when the pilot operates the primary flight controls in a normal manner; or

(2) Limit the operation of the aeroplane so that the pilot receives unmistakable warning at the start of take-off.

(b) The device must have means to preclude the possibility of it becoming inadvertently engaged in flight.

525.681 *Limit Load Static Tests*

(a) Compliance with the limit load requirements of this chapter must be shown by tests in which:

(1) The direction of the test loads produces the most severe loading in the control system; and

(2) Each fitting, pulley, and bracket used in attaching the system to the main structure is included.

(b) Compliance must be shown (by analyses or individual load tests) with the special factor requirements for control system joints subject to angular motion.

525.683 *Operation Tests*

It must be shown by operation tests that when portions of the control system subject to pilot effort loads are loaded to 80 percent of the limit load specified for the system and the powered

portions of the control system are loaded to the maximum load expected in normal operation, the system is free from:

(a) Jamming;

(b) Excessive friction; and

(c) Excessive deflection.

525.685 *Control System Details*

(a) Each detail of each control system must be designed and installed to prevent jamming, chafing, and interference from cargo, passengers, loose objects, or the freezing of moisture.

(b) There must be means in the cockpit to prevent the entry of foreign objects into places where they would jam the system.

(c) There must be means to prevent the slapping of cables or tubes against other parts.

(d) Sections 525.689 and 525.693 apply to cable systems and joints.

525.689 *Cable Systems*

(a) Each cable, cable fitting, turnbuckle, splice, and pulley must be approved. In addition:

(1) No cable smaller than 1/8 inch in diameter may be used in the aileron, elevator, or rudder systems; and

(2) Each cable system must be designed so that there will be no hazardous change in cable tension throughout the range of travel under operating conditions and temperature variations.

(b) Each kind and size of pulley must correspond to the cable with which it is used. Pulleys and sprockets must have closely fitted guards to prevent the cables and chains from being displaced or fouled. Each pulley must lie in the plane passing through the cable so that the cable does not rub against the pulley flange.

(c) Fairleads must be installed so that they do not cause a change in cable direction of more than three degrees.

(d) Clevis pins subject to load or motion and retained only by cotter pins may not be used in the control system.

(e) Turnbuckles must be attached to parts having angular motion in a manner that will positively prevent binding throughout the range of travel.

(f) There must be provisions for visual inspection of fairleads, pulleys, terminals, and turnbuckles.

525.693 *Joints*

Control system joints (in push-pull systems) that are subject to angular motion, except those in ball and roller bearing systems, must have a special factor of safety of not less than 3.33 with respect to the ultimate bearing strength of the softest material used as a bearing. This factor may be reduced to 2.0 for joints in cable control systems. For ball or roller bearings, the approved ratings, may not be exceeded.

(Change 525-3 (91-11-01))

525.697 *Lift and Drag Devices, Controls*

(a) Each lift device control must be designed so that the pilots can place the device in any take-off, en route, approach, or landing position established under 525.101*(d)*. Lift and drag devices must maintain the selected positions, except for movement produced by an automatic positioning or load limiting device, without further attention by the pilots.

(b) Each lift and drag device control must be designed and located to make inadvertent operation improbable. Lift and drag devices intended for ground operation only must have means to prevent operation of their controls in flight unless it is demonstrated that operation of the control is not hazardous.

FAR:

(b) Each lift and drag device control must be designed and located to make inadvertent operation improbable. Lift and drag devices intended for ground operation only must have means to prevent the inadvertent operation of their controls in flight if that operation could be hazardous.

(c) The rate of motion of the surface in response to the operation of the control and the characteristics of the automatic positioning or load limiting device must give satisfactory flight and performance characteristics under steady or changing conditions of airspeed, engine power, and aeroplane attitude.

(d) The lift device control must be designed to retract the surfaces from the fully extended position, during steady flight at maximum continuous engine power, and at any speed below $V_F + 9.0$ (knots).

525.699 *Lift and Drag Device Indicator*

(a) There must be means to indicate to the pilots the position of each lift or drag device having a separate control in the cockpit to adjust its position. In addition, an indication of unsymmetrical operation or other malfunction in the lift or drag service systems must be provided when such indication is necessary to enable the pilots to prevent or counteract an unsafe flight or ground condition, considering the effects on flight characteristics and performance.

(b) There must be means to indicate to the pilots the take-off, en route approach, and landing lift device positions.

(c) If any extension of the lift and drag devices beyond the landing position is possible, the control must be clearly marked to identify this range of extension.

(d) Lift and drag devices (other than flaps and leading edge devices) must have a device to warn the pilot that the control is operated, unless it is demonstrated that operation of the control is not hazardous.

FAR:

No equivalent text.

525.701 *Flap and Slat Interconnection*

(a) Unless the aeroplane has safe flight characteristics with the flaps or slats retracted on one side and extended on the other, the motion of flaps or slats on opposite sides of the plane of symmetry must be synchronised by a mechanical interconnection or approved equivalent means.

(b) If a wing flap or slat interconnection or equivalent means is used, it must be designed to account for the applicable unsymmetrical loads, including those resulting from flight with the engines on one side of the plane of symmetry inoperative and the remaining engines at take-off power.

(c) For aeroplanes with flaps or slats that are not subjected to slipstream conditions, the structure must be designed for the loads imposed when the wing flaps or slats on one side are carrying the most severe load occurring in the prescribed symmetrical conditions and those on the other side are carrying not more than 80 percent of that load.

(d) The flap interconnection must be designed for the loads resulting when the flap or slats surfaces on one side of the plane of symmetry are jammed and immovable while the surface on the other side are free to move and the full power of the surface actuating system is applied.

(Change 525-3 (91-11-01))

525.703 *Take-off Warning System*

A take-off warning system must be installed and must meet the following requirements:

(a) The system must provide to the pilots an aural warning that is automatically activated during the initial portion of the take-off roll if the aeroplane is in a configuration, including any of the following, that would not allow a safe take-off:

(1) The wing flaps or leading edge devices are not within the approved range of take-off positions.

(2) Wing spoilers (except lateral control spoilers meeting the requirements of 525.671), speed brakes, or longitudinal trim devices are in a position that would not allow a safe take-off.

(b) The warning required by paragraph *(a)* of this section must continue until:

(1) The configuration is changed to allow a safe take-off;

(2) Action is taken by the pilot to terminate the take-off roll;

(3) The aeroplane is rotated for take-off; or

(4) The warning is manually deactivated by the pilot.

(c) The means used to activate the system must function properly throughout the ranges of take-off weights, altitudes, and temperatures for which certification is requested.

Landing Gear

525.721 *General*

(a) The main landing gear system must be designed so that if it fails due to overloads during take-off and landing (assuming the overloads to act in the upward and aft directions), the failure mode is not likely to cause:

(1) For aeroplanes that have a passenger seating configuration, excluding pilots seats, of nine seats or less, the spillage of enough fuel from any fuel system in the fuselage to constitute a fire hazard; and

(2) For aeroplanes that have a passenger seating configuration, excluding pilots seats, of 10 seats or more, the spillage of enough fuel from any part of the fuel system to constitute a fire hazard.

(b) Each aeroplane that has a passenger seating configuration excluding pilots seats, of 10 or more must be designed so that with the aeroplane under control it can be landed on a paved runway with any one or more landing gear legs not extended without sustaining a structural component failure that is likely to cause the spillage of enough fuel to constitute a fire hazard.

(c) Compliance with the provisions of this section may be shown by analysis or tests, or both.

525.723 *Shock Absorption Tests*

(a) The analytical representation of the landing gear dynamic characteristics that is used in determining the landing loads shall be validated by energy absorption tests. A range of tests shall be conducted to ensure that the analytical representation is valid for the design conditions specified in section 525.473.
(amended 2001/10/01)

(1) The configurations subjected to energy absorption tests at limit design conditions shall include at least the design landing weight or the design takeoff weight, whichever produces the greater value of landing impact energy.

(2) The test attitude of the landing gear unit and the application of appropriate drag loads during the test shall simulate the aeroplane landing conditions in a manner consistent with the development of rational or conservative limit loads.

(b) The landing gear may not fail in a test, demonstrating its reserve energy absorption capacity, simulating a descent velocity of 12 f.p.s. at design landing weight, assuming aeroplane lift not greater than aeroplane weight acting during the landing impact.
(amended 2001/10/01)

(c) In lieu of the tests prescribed in this section, changes in previously approved design weights and minor changes in design may be substantiated by analyses based on previous tests conducted on the same basic landing gear system that has similar energy absorption characteristics.
(amended 2001/10/01)

(Change 525-3 (91-11-01)

525.725 ***(Reserved)***
(amended 2001/10/01)

525.727 ***(Reserved)***
(amended 2001/10/01)

525.729 *Retracting Mechanism*

(a) General. For aeroplanes with retractable landing gear, the following apply:

(1) The landing gear retracting mechanism, wheel well doors, and supporting structure, must be designed for:

(i) The loads occurring in the flight conditions when the gear is in the retracted position;

(ii) The combination of friction loads, inertia loads, brake torque loads, air loads, and gyroscopic loads resulting from the wheels rotating at a peripheral speed equal to 1.3 V_S (with the flaps in take-off position at design take-off weight), occurring during retraction and extension at any airspeed up to 1.6 V_{S1} (with the flaps in the approach position at design landing weight), and

(iii) Any load factor up to those specified in 525.345(a) for the flaps extended condition.

(2) Unless there are other means to decelerate the aeroplane in flight at this speed, the landing gear, the retracting mechanism, and the aeroplane structure (including wheel well doors) must be designed to withstand the flight loads occurring with the landing gear in the extended position at any speed up to 0.67 V_C.

(3) Landing gear doors, their operating mechanism, and their supporting structures must be designed for the yawing manoeuvres prescribed for the aeroplane in addition to the conditions of airspeed and load factor prescribed in subparagraphs (1) and (2) of this paragraph.

(b) Landing gear lock. There must be positive means to keep the landing gear extended, in flight and on the ground.

(c) Emergency operation. There must be an emergency means for extending the landing gear in the event of:

(1) Any reasonably probable failure in the normal retraction system; or

(2) The failure of any single source of hydraulic, electric, or equivalent energy supply.

(d) Operation test. The proper functioning of the retracting mechanism must be shown by operation tests.

(e) Position indicator and warning device. If a retractable landing gear is used, there must be a landing gear position indicator (as well as necessary switches to actuate the indicator) or other means to inform the pilot that the gear is secured in the extended (or retracted) position. This means must be designed as follows:

(1) If switches are used, they must be located and coupled to the landing gear mechanical systems in a manner that prevents an erroneous indication of "down and locked" if the landing gear is not in a fully extended position, or of "up and locked" if the landing gear is not in the fully retracted position. The switches may be located where they are operated by the actual landing gear locking latch or device.

(2) The flight crew must be given an aural warning that functions continuously, or is periodically repeated, if a landing is attempted when the landing gear is not locked down.

(3) The warning must be given in sufficient time to allow the landing gear to be locked down or a go-around to be made.

(4) There must not be a manual shut-off means readily available to the flight crew for the warning required by paragraph (e)(2) of this section such that it could be operated instinctively, inadvertently, or by habitual reflexive action.

(5) The system used to generate the aural warning must be designed to eliminate false or inappropriate alerts.

(6) Failures of systems used to inhibit the landing gear aural warning, that would prevent the warning system from operating, must be improbable.

(f) Protection of equipment in wheel wells. Equipment that is essential to safe operation of the aeroplane and that is located in wheel wells must be protected from the damaging effects of:

(1) A bursting tire, unless it is shown that a tire cannot burst from overheat; and

(2) A loose tire tread, unless it is shown that a loose tire tread cannot cause damage.

(Change 525-3 (91-11-01))
(Change 525-4 (92-08-01))

525.731 *Wheels*

(a) Each main and nose wheel shall be approved.
(amended 2003/11/10)

(b) The maximum static load rating of each wheel may not be less than the corresponding static ground reaction with:

(1) Design maximum weight; and

(2) Critical centre of gravity.

(c) The maximum limit load rating of each wheel shall equal or exceed the maximum radial limit load determined under the applicable ground load requirements of this chapter.
(amended 2003/11/10)

(d) Overpressure burst prevention. Means shall be provided in each wheel to prevent wheel failure and tire burst that may result from excessive pressurization of the wheel and tire assembly.
(amended 2003/11/10)

(e) Braked wheels. Each braked wheel shall meet the applicable requirements of 525.735. (amended 2003/11/10)

(Change 525-3 (91-11-01))

525.733 *Tires*

(a) When a landing gear axle is fitted with a single wheel and tire assembly, the wheel must be fitted with a suitable tire of proper fit with a speed rating approved by the Minister that is not exceeded under critical conditions and with a load rating approved by the Minister that is not exceeded under:

(1) The loads on the main wheel tire, corresponding to the most critical combination of aeroplane weight (up to the maximum weight), and centre of gravity position; and

(2) The loads corresponding to the ground reactions in paragraph (b) of this section, on the nose wheel tire, except as provided in paragraphs (b)(2) and (b)(3) of this section.

(b) The applicable ground reactions for nose wheel tires are as follows:

(1) The static ground reaction for the tire corresponding to the most critical combination of aeroplane weight (up to maximum ramp weight) and centre of gravity position with a force of 1.0g acting downward at the centre of gravity. This load may not exceed the load rating of the tire.

(2) The ground reaction of the tire corresponding to the most critical combination of aeroplane weight (up to maximum landing weight) and centre of gravity position combined with forces of 1.0g downward and 0.31g forward acting at the centre of gravity. The reactions in this case must be distributed to the nose and main wheels by the principles of statics with a drag reaction equal to 0.31 times the vertical load at each wheel with brakes capable of producing this ground reaction. This nose tire load may not exceed 1.5 times the load rating of the tire.

(3) The ground reaction of the tire corresponding to the most critical combination of aeroplane weight (up to maximum ramp weight) and centre of gravity position combined with forces of1.0g downward and 0.20g forward acting at the centre of gravity. The reactions in this case must be distributed to the nose and main wheels by the principles of statics with a drag reaction equal to 0.20 times the vertical load at each wheel with brakes capable of producing this ground reaction. This nose tire load may not exceed 1.5 times the load rating of the tire.

(c) When a landing gear axle is fitted with more than one wheel and tire assembly, such as dual or dual-tandem, each wheel must be fitted with a suitable tire of proper fit with a speed rating approved by the Minister that is not exceeded under critical conditions, and with a load rating approved by the Minister that is not exceeded by:

(1) The loads on the main wheel tire, corresponding to the most critical combination of aeroplane weight (up to maximum weight) and centre of gravity position, when multiplied by a factor of 1.07; and

(2) Loads specified in paragraphs (a)(2), (b)(1), (b)(2), and (b)(3) of this section on each nose wheel tire.

(d) Each tire installed on a retractable landing gear system must, at the maximum size of the tire type expected in service, have a clearance to surrounding structure and systems that is adequate to prevent unintended contact between the tire and any part of the structure or systems.

(e) For an aeroplane with a maximum certified take-off weight of more than 75,000 pounds, tires mounted on braked wheels must be inflated with dry nitrogen or other gases shown to be inert so that the gas mixture in the tire does not contain oxygen in excess of 5 percent by volume, unless it can be shown that the tire liner material will not produce a volatile gas when heated or that means are provided to prevent tire temperatures from reaching unsafe levels.

(Change 525-3 (91-11-01))
(Change 525-6 (93-12-30))

525.735 *Brakes*

(a) Approval. Each assembly consisting of a wheel(s) and brake(s) shall be approved.
(amended 2003/11/10)

(b) Brake system capability. The brake system, associated systems and components shall be designed and constructed so that:
(amended 2003/11/10)

(1) If any electrical, pneumatic, hydraulic or mechanical connecting or transmitting element (excluding the operating pedal or handle) fails, or if any single source of hydraulic or other brake operating energy supply is lost, it is possible to bring the aeroplane to rest with a braked roll stopping distance of not more than two times that obtained in determining the landing distance as prescribed in section 525.125.
(amended 2003/11/10)

(2) Fluid lost from a brake hydraulic system following a failure in, or in the vicinity of, the brakes is insufficient to cause or support a hazardous fire on the ground or in flight.
(amended 2003/11/10)

(c) Brake controls. The Brake controls shall be designed and constructed so that:
(amended 2003/11/10)

(1) Excessive control force is not required for their operation.
(amended 2003/11/10)

(2) If an automatic braking system is installed, means are provided to:
(amended 2003/11/10)

(i) Arm and disarm the system, and

(ii) Allow the pilot(s) to override the system by use of manual braking.

(d) Parking brake. The aeroplane shall have a parking brake control that, when selected on, will, without further attention, prevent the aeroplane from rolling on a dry and level paved runway when the most adverse combination of maximum thrust on one engine and up to maximum ground idle thrust on any, or all, other engine(s) is applied. The control shall be suitably located or be adequately protected to prevent inadvertent operation. There shall be

indication in the cockpit when the parking brake is not fully released.
(amended 2003/11/10)

(e) Antiskid system. If an antiskid system is installed:
(amended 2003/11/10)

(1) It shall operate satisfactorily over the range of expected runway conditions, without external adjustment.

(2) It shall, at all times, have priority over the automatic braking system, if installed.

(f) Kinetic energy capacity.

(1) *Design landing stop.* The design landing stop is an operational landing stop at maximum landing weight. The design landing stop brake kinetic energy absorption requirement of each wheel, brake, and tire assembly shall be determined. It shall be substantiated by dynamometer testing that the wheel, brake, and tire assembly is capable of absorbing not less than this level of kinetic energy throughout the defined wear range of the brake. The energy absorption rate derived from the aeroplane manufacturer's braking requirements shall be achieved. The mean deceleration shall not be less than 10 fps^2.
(amended 2003/11/10)

(2) *Maximum kinetic energy accelerate-stop.* The maximum kinetic energy accelerate-stop is a rejected takeoff for the most critical combination of aeroplane takeoff weight and speed. The accelerate-stop brake kinetic energy absorption requirement of each wheel, brake, and tire assembly shall be determined. It shall be substantiated by dynamometer testing that the wheel, brake, and tire assembly is capable of absorbing not less than this level of kinetic energy throughout the defined wear range of the brake. The energy absorption rate derived from the aeroplane manufacturer's braking requirements shall be achieved. The mean deceleration shall not be less than 6 fps^2.
(amended 2003/11/10)

(3) *Most severe landing stop.* The most severe landing stop is a stop at the most critical combination of aeroplane landing weight and speed. The most severe landing stop brake kinetic energy absorption requirement of each wheel, brake, and tire assembly shall be determined. It shall be substantiated by dynamometer testing that, at the declared fully worn limit(s) of the brake heat sink, the wheel, brake and tire assembly is capable of absorbing not less than this level of kinetic energy. The most severe landing stop need not be considered for extremely improbable failure conditions or if the maximum kinetic energy accelerate-stop energy is more severe.
(amended 2003/11/10)

(g) Brake condition after high kinetic energy dynamometer stop(s). Following the high kinetic energy stop demonstration(s) required by subsection *(f)* of this section, with the parking brake promptly and fully applied for at least 3 minutes, it shall be demonstrated that for at least 5 minutes from application of the parking brake, no condition occurs (or has occurred during the stop), including fire associated with the tire or wheel and brake assembly, that could prejudice the safe and complete evacuation of the aeroplane.
(amended 2003/11/10)

(h) Stored energy systems. An indication to the flight crew of the usable stored energy shall be provided if a stored energy system is used to demonstrate compliance with paragraph *(b)*(1) of this section. The available stored energy shall be sufficient for:
(amended 2003/11/10)

(1) At least 6 full applications of the brakes when an antiskid system is not operating; and

(2) Bringing the aeroplane to a complete stop when an antiskid system is operating, under all runway surface conditions for which the aeroplane is certificated.

(i) *Brake wear indicators.* Means shall be provided for each brake assembly to indicate when the heat sink is worn to the permissible limit. The means shall be reliable and readily visible.
(amended 2003/11/10)

(j) Overtemperature burst prevention. Means shall be provided in each braked wheel to prevent a wheel failure, a tire burst, or both, that may result from elevated brake temperatures. Additionally, all wheels shall meet the requirements of 525.731*(d).*
(amended 2003/11/10)

(k) Compatibility. Compatibility of the wheel and brake assemblies with the aeroplane and its systems shall be substantiated.
(amended 2003/11/10)

(Change 525-3 (91-11-01))
(Change 525-8)

525.737 *Skis*

Each ski must be approved. The maximum limit load rating of each ski must equal or exceed the maximum limit load determined under the applicable ground load requirements of this chapter.

Floats and Hulls

525.751 *Main Float Buoyancy*

Each main float must have:

(a) A buoyancy of 80 percent in excess of that required to support the maximum weight of the seaplane or amphibian in fresh water; and

(b) Not less than five watertight compartments approximately equal in volume.

525.753 *Main Float Design*

Each main float must be approved and must meet the requirements of 525.521.

525.755 *Hulls*

(a) Each hull must have enough watertight compartments so that, with any two adjacent compartments flooded, the buoyancy of the hull and auxiliary floats (and wheel tires, if used) provides a margin of positive stability great enough to minimise the probability of capsizing in rough, fresh water.

(b) Bulkheads with watertight doors may be used for communication between compartments.

Personnel and Cargo Accommodations

525.771 *Pilot Compartment*

(a) Each pilot compartment and its equipment must allow the minimum flight crew (established under 525.1523) to perform their duties without unreasonable concentration or fatigue.

(b) The primary controls listed in 525.779*(a)*, excluding cables and control rods, must be located with respect to the propellers so that no member of the minimum flight crew (established under 525.1523), or part of the controls, lies in the region between the plane of rotation of any inboard propeller and the surface generated by a line passing through the centre of the propeller hub making an angle of five degrees forward or aft of the plane of rotation of the propeller.

(c) If provision is made for a second pilot, the aeroplane must be controllable with equal safety from either pilot seat.

(d) The pilot compartment must be constructed so that, when flying in rain or snow, it will not leak in a manner that will distract the crew or harm the structure.

(e) Vibration and noise characteristics of cockpit equipment may not interfere with safe operation of the aeroplane.

525.772 *Pilot Compartment Doors*

For an aeroplane that has a lockable door installed between the pilot compartment and the passenger compartment:

(a) If the aeroplane has a maximum passenger seating configuration of 20 seats or more, the emergency exit configuration must be designed so that neither crew members nor passengers require use of the flight deck door in order to reach the emergency exits provided for them;

(b) Means must be provided to enable flight crew members to directly enter the passenger compartment from the pilot compartment if the flight deck door becomes jammed; and

(c) Emergency means must be provided to enable a crew member to enter the pilot compartment in the event that the flight crew becomes incapacitated.

(Change 525-3 (91-11-01))
(Change 525-8.1 (2002-03-21))

525.773 *Pilot Compartment View*

(a) Non-precipitation conditions. For non-precipitation conditions, the following apply:

(1) Each pilot compartment must be arranged to give the pilots a sufficiently extensive, clear, and undistorted view, to enable them to safely perform any manoeuvres within the operating limitations of the aeroplane, including taxiing, take-off, approach, and landing.

(2) Each pilot compartment must be free of glare and reflection that could interfere with the normal duties of the minimum flight crew (established under 525.1523).This must be shown in day and night flight tests under non-precipitation conditions.

(b) Precipitation conditions. For precipitation conditions, the following apply:

(1) The aeroplane shall have a means to maintain a clear portion of the windshield during precipitation conditions, sufficient for both pilots to have a sufficiently extensive view along the flight path in normal flight attitudes of the aeroplane. This means shall be designed to function, without continuous attention on the part of the flight crew, in:
(amended 2008/10/30)

(i) Heavy rain at speeds up to 1.5 V_{SR1} with lift and drag devices retracted; and
(amended 2003/11/10)

(ii) The icing conditions specified in 525.1419 if certification for flight in icing conditions is requested.
(amended 2008/10/30)

(2) The first pilot shall have:
(amended 2003/11/10)

(i) A window that is openable under the conditions prescribed in paragraph (b)(1) of this section when the cabin is not pressurized, provides the view specified in that paragraph, and gives sufficient protection form the elements against impairment of the pilot's vision; or

(ii) An alternate means to maintain a clear view under the conditions specified in paragraph (b)(1) of this section, considering the probable damage due to a severe hail encounter.

(c) Internal windshield and window fogging. The aeroplane must have a means to prevent fogging of the internal portions of the windshield and window panels over an area which would provide the visibility specified in paragraph *(a)* of this section under all internal and external ambient conditions, including precipitation conditions, in which the aeroplane is intended to be operated.

(d) Fixed markers or other guides must be installed at each pilot station to enable the pilots to position themselves in their seats for an optimum combination of outside visibility and instrument scan. If lighted markers or guides are used they must comply with the requirements specified in 525.1381.

(Change 525-3 (91-11-01))

525.775 *Windshields and Windows*

(a) Internal panes must be made of non-splintering material.

(b) Windshield panes directly in front of the pilots in the normal conduct of their duties, and the supporting structures for these panes, must withstand, without penetration, the impact of a four-pound bird when the velocity of the aeroplane (relative to the bird along the aeroplane's flight path) is equal to the value of V_C, at sea level, selected under 525.335*(a)*.

(c) Unless it can be shown by analysis or tests that the probability of occurrence of a critical windshield fragmentation condition is of a low order, the aeroplane must have a means to minimise the danger to the pilots from flying windshield fragments due to bird impact. This must be shown for each transparent pane in the cockpit that:

(1) Appears in the front view of the aeroplane;

(2) Is inclined 15 degrees or more to the longitudinal axis of the aeroplane; and

(3) Has any part of the pane located where its fragmentation will constitute a hazard to the pilots.

(d) The design of windshields and windows in pressurised aeroplanes must be based on factors peculiar to high altitude operation, including the effects of continuous and cyclic pressurisation loadings, the inherent characteristics of the material used, and the effects of temperatures and temperature differentials. The windshield and window panels must be capable of withstanding the maximum cabin pressure differential loads combined with critical aerodynamic pressure and temperature effects after any single failure in the installation or associated systems. It may be assumed that, after a single failure that is obvious to the flight crew (established under 525.1523), the cabin pressure differential is reduced from the maximum, in accordance with appropriate operating limitations, to allow continued safe flight of the aeroplane with a cabin pressure altitude of not more than 15,000 feet.

(e) The windshield panels in front of the pilots must be arranged so that, assuming the loss of vision through any one panel, one or more panels remain available for use by a pilot seated at a pilot station to permit continued safe flight and landing.

525.777 *Cockpit Controls*

(a) Each cockpit control must be located to provide convenient operation and to prevent confusion and inadvertent operation.

(b) The direction of movement of cockpit controls must meet the requirements of 525.779. Wherever practicable, the sense of motion involved in the operation of other controls must correspond to the sense of the effect of the operation upon the aeroplane or upon the part operated. Controls of a variable nature using a rotary motion must move clockwise from the off position, through an increasing range, to the full on position.

(c) The controls must be located and arranged, with respect to the pilots' seats, so that there is full and unrestricted movement of each control without interference from the cockpit structure or the clothing of the minimum flight crew (established under 525.1523) when any member of this flight crew, from 5'2" to 6'3" in height, is seated with the seat belt and shoulder harness (if provided) fastened.

(d) Identical powerplant controls for each engine must be located to prevent confusion as to the engines they control.

(e) Wing flap controls and other auxiliary lift device controls must be located on top of the pedestal, aft of the throttles, centrally or to the right of the pedestal centreline, and not less than 10 inches aft of the landing gear control.

(f) The landing gear control must be located forward of the throttles and must be operable by each pilot when seated with seat belt and shoulder harness (if provided) fastened.

(g) Control knobs must be shaped in accordance with 525.781. In addition, the knobs must be of the same colour, and this colour must contrast with the colour of control knobs for other purposes and the surrounding cockpit.

(h) If a flight engineer is required as part of the minimum flight crew (established under 525.1523), the aeroplane must have a flight engineer station located and arranged so that the flight crew members can perform their functions efficiently and without interfering with each other.

525.779 *Motion and Effect of Cockpit Controls*

Cockpit controls must be designed so that they operate in accordance with the following movement and actuation:

(a) Aerodynamic controls:

(1) *Primary.*

Controls	Motion And Effect
Aileron	Right (clockwise) for right wing down.
Elevator	Rearward for nose up.
Rudder	Right pedal forward for nose right.

(1) *Secondary.*

Controls	Motion And Effect
Flaps (or auxiliary lift devices).	Forward for flaps up, rearward for flaps down.
Trim tabs (or equivalent).	Rotate to produce similar rotation of the aeroplane about an axis parallel to the axis of the control.

(b) Powerplant and auxiliary controls:

(1) *Powerplant.*

Controls	Motion And Effect
Power or thrust	Forward to increase forward thrust and rearward to increase rearward thrust.
Propellers	Forward to increase rpm.
Mixture	Forward of upward for rich.
Carburettor air heat	Forward of upward for cold.
Supercharger	Forward of upward for low blower. for turbosuperchargers, forward, upward, or clockwise, to increase pressure.

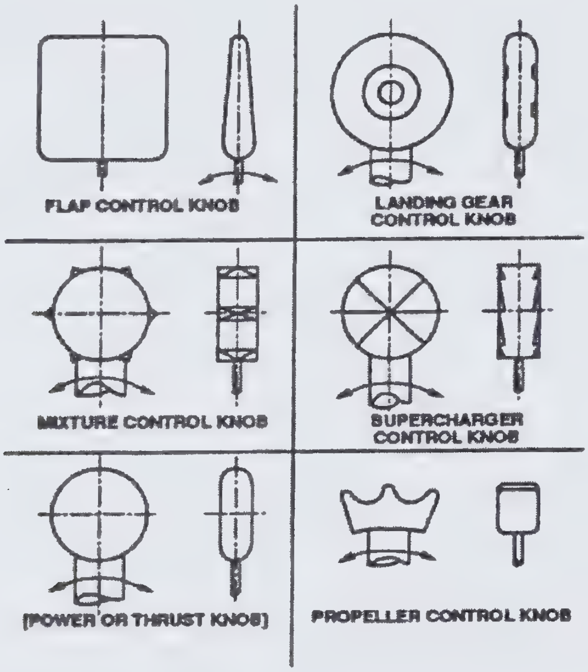
(2) *Auxiliary.*

Controls	Motion And Effect
Landing Gear	Down to extend.

(Change 525-3 (91-11-01))

525.781 *Cockpit Control Knob Shape*

Cockpit control knobs must conform to the general shapes (but not necessarily the exact sizes or specific proportions) in the following figure:



(Change 525-3 (91-11-01))

525.783 *Fuselage Doors*

(amended 2007/03/08)

(a) General. This section applies to fuselage doors, which includes all doors, hatches, openable windows, access panels, covers, etc., on the exterior of the fuselage that do not require the use of tools to open or close. This also applies to each door or hatch through a pressure bulkhead, including any bulkhead that is specifically designed to function as a secondary bulkhead under the prescribed failure conditions of AWM Chapter 525. These doors shall meet the requirements of this section, taking into account both pressurized and unpressurized flight, and shall be designed as follows:
(amended 2007/03/08)

(1) Each door shall have means to safeguard against opening in flight as a result of mechanical failure, or failure of any single structural element.
(amended 2007/03/08)

(2) Each door that could be a hazard if it unlatches shall be designed so that unlatching during pressurized and unpressurized flight from the fully closed, latched, and locked

condition is extremely improbable. This shall be demonstrated by safety analysis.
(amended 2007/03/08)

(3) Each element of each door operating system shall be designed or, where impracticable, distinctively and permanently marked, to minimize the probability of incorrect assembly and adjustment that could result in a malfunction.
(amended 2007/03/08)

(4) All sources of power that could initiate unlocking or unlatching of any door shall be automatically isolated from the latching and locking systems prior to flight and it shall not be possible to restore power to the door during flight.
(amended 2007/03/08)

(5) Each removable bolt, screw, nut, pin, or other removable fastener shall meet the locking requirements of 525.607.
(amended 2007/03/08)

(6) Certain doors, as specified by 525.807(h), shall also meet the applicable requirements of 525.809 through 525.812 for emergency exits.
(amended 2007/03/08)

(b) Opening by persons. There shall be a means to safeguard each door against opening during flight due to inadvertent action by persons. In addition, design precautions shall be taken to minimize the possibility for a person to open a door intentionally during flight. If these precautions include the use of auxiliary devices, those devices and their controlling systems shall be designed so that:
(amended 2007/03/08)

(1) No single failure will prevent more than one exit from being opened; and
(amended 2007/03/08)

(2) Failures that would prevent opening of the exit after landing are improbable.
(amended 2007/03/08)

(c) Pressurization prevention means. There shall be a provision to prevent pressurization of the aeroplane to an unsafe level if any door subject to pressurization is not fully closed, latched, and locked.
(amended 2007/03/08)

(1) The provision shall be designed to function after any single failure, or after any combination of failures not demonstrated to be extremely improbable.
(amended 2007/03/08)

(2) Doors that meet the conditions described in (h) of this section are not required to have a dedicated pressurization prevention means if, from every possible position of the door, it will remain open to the extent that it prevents pressurization or safely close and latch as pressurization takes place. This shall also be demonstrated with any single failure and malfunction, except that:
(amended 2007/03/08)

(i) With failures or malfunctions in the latching mechanism, it need not latch after closing; and
(amended 2007/03/08)

(ii) With jamming as a result of mechanical failure or blocking debris, the door need not close and latch if it can be demonstrated that the pressurization loads on the jammed door or mechanism would not result in an unsafe condition.
(amended 2007/03/08)

(d) Latching and locking. The latching and locking mechanisms shall be designed as follows:
(amended 2007/03/08)

(1) There shall be a provision to latch each door.
(amended 2007/03/08)

(2) The latches and their operating mechanism shall be designed so that, under all aeroplane flight and ground loading conditions, with the door latched, there is no force or torque tending to unlatch the latches. In addition, the latching system shall include a means to secure the latches in the latched position. This means shall be independent of the locking system.
(amended 2007/03/08)

(3) Each door subject to pressurization, and for which the initial opening movement is not inward, shall:
(amended 2007/03/08)

(i) Have an individual lock for each latch;
(amended 2007/03/08)

(ii) Have the lock located as close as practicable to the latch; and
(amended 2007/03/08)

(iii) Be designed so that, during pressurized flight, no single failure in the locking system would prevent the locks from restraining the latches necessary to secure the door.
(amended 2007/03/08)

(4) Each door for which the initial opening movement is inward, and unlatching of the door could result in a hazard, shall have a locking means to prevent the latches from becoming disengaged. The locking means shall ensure sufficient latching to prevent opening of the door even with a single failure of the latching mechanism.
(amended 2007/03/08)

(5) It shall not be possible to position the lock in the locked position if the latch and the latching mechanism are not in the latched position.
(amended 2007/03/08)

(6) It shall not be possible to unlatch the latches with the locks in the locked position. Locks shall be designed to withstand the limit loads resulting from:
(amended 2007/03/08)

(i) The maximum operator effort when the latches are operated manually;
(amended 2007/03/08)

(ii) The powered latch actuators, if installed; and
(amended 2007/03/08)

(iii) The relative motion between the latch and the structural counterpart.
(amended 2007/03/08)

(7) Each door for which unlatching would not result in a hazard is not required to have a locking mechanism meeting the requirements of (d)(3) through (d)(6) of this section.
(amended 2007/03/08)

(e) Warning, caution, and advisory indications. Doors shall be provided with the following indications:
(amended 2007/03/08)

(1) There shall be a positive means to indicate at each door operator's station that all required operations to close, latch, and lock the door(s) have been completed.
(amended 2007/03/08)

(2) There shall be a positive means clearly visible from each operator station for any door that could be a hazard if unlatched to indicate if the door is not fully closed, latched, and locked.
(amended 2007/03/08)

(3) There shall be a visual means on the flight deck to signal the pilots if any door is not fully closed, latched, and locked. The means shall be designed such that any failure or combination of failures that would result in an erroneous closed, latched, and locked indication is improbable for:
(amended 2007/03/08)

(i) Each door that is subject to pressurization and for which the initial opening movement is not inward; or
(amended 2007/03/08)

(ii) Each door that could be a hazard if unlatched.
(amended 2007/03/08)

(4) There shall be an aural warning to the pilots prior to or during the initial portion of take-off roll if any door is not fully closed, latched, and locked, and its opening would prevent a safe take-off and return to landing.
(amended 2007/03/08)

(f) Visual inspection provision. Each door for which unlatching of the door could be a hazard shall have a provision for direct visual inspection to determine, without ambiguity, if the door is fully closed, latched, and locked. The provision shall be permanent and discernible under operational lighting conditions, or by means of a flashlight or equivalent light source.
(amended 2007/03/08)

(g) Certain maintenance doors, removable emergency exits, and access panels. Some doors not normally opened except for maintenance purposes or emergency evacuation and some

access panels need not comply with certain paragraphs of this section as follows:
(amended 2007/03/08)

(1) Access panels that are not subject to cabin pressurization and would not be a hazard if open during flight need not comply with (a) through (f) of this section, but shall have a means to prevent inadvertent opening during flight.
(amended 2007/03/08)

(2) Inward-opening removable emergency exits that are not normally removed, except for maintenance purposes or emergency evacuation, and flight deck-openable windows need not comply with (c) and (f) of this section.
(amended 2007/03/08)

(3) Maintenance doors that meet the conditions of (h) of this section, and for which a placard is provided limiting use to maintenance access, need not comply with (c) and (f) of this section.
(amended 2007/03/08)

(h) Doors that are not a hazard. For the purposes of this section, a door is considered not to be a hazard in the unlatched condition during flight, provided it can be demonstrated to meet all of the following conditions:
(amended 2007/03/08)

(1) Doors in pressurized compartments would remain in the fully closed position if not restrained by the latches when subject to a pressure greater than 0.0352 kg/cm^2 (1/2 psi). Opening by persons, either inadvertently or intentionally, need not be considered in making this determination.
(amended 2007/03/08)

(2) The door would remain inside the aeroplane or remain attached to the aeroplane if it opens either in pressurized or unpressurized portions of the flight. This determination shall include the consideration of inadvertent and intentional opening by persons during either pressurized or unpressurized portions of the flight.
(amended 2007/03/08)

(3) The disengagement of the latches during flight would not allow depressurization of the cabin to an unsafe level. This safety assessment shall include the physiological effects on the occupants.
(amended 2007/03/08)

(4) The open door during flight would not create aerodynamic interference that could preclude safe flight and landing.
(amended 2007/03/08)

(5) The aeroplane would meet the structural design requirements with the door open. This assessment shall include the aeroelastic stability requirements of 525.629, as well as the strength requirements of Subchapter C of this Chapter.
(amended 2007/03/08)

(6) The unlatching or opening of the door shall not preclude safe flight and landing as a result of interaction with other systems or structures.
(amended 2007/03/08)

(Change 525-3 (91-11-01))
(Change 525-8)

525.785 *Seats, Berths, Safety Belts, and Harnesses*

(a) A seat (or berth for a non-ambulant person) must be provided for each occupant who has reached his or her second birthday.

(b) Each seat, berth, safety belt, harness, and adjacent part of the aeroplane at each station designated as occupiable during take-off and landing must be designed so that a person making proper use of these facilities will not suffer serious injury in an emergency landing as a result of the inertia forces specified in 525.561 and 525.562.

(c) Each seat and berth must be approved.

(d) Each occupant of a seat that makes more than an 18 degree angle with the vertical plane containing the aeroplane centreline, must be protected from head injury by a safety belt and an energy absorbing rest that will support the arms, shoulders, head, and spine, or by a safety belt and shoulder harness that will prevent the head from contacting any injurious object. Each occupant of any other seat must be protected from head injury by a safety belt and, as appropriate to the type, location, and angle of facing of each seat, by one or more of the following:

(1) A shoulder harness that will prevent the head from contacting any injurious object.

(2) The elimination of any injurious object within striking radius of the head.

(3) An energy absorbing rest that will support the arms, shoulders, head, and spine.

(e) Each berth must be designed so that the forward part has a padded end board, canvas diaphragm, or equivalent means, that can withstand the static load reaction of the occupant when subjected to the forward inertia force specified in 525.561. Berths must be free from corners and protuberances likely to cause serious injury to a person occupying the berth during emergency conditions.

(f) Each seat or berth, and its supporting structure, and each safety belt or harness and its anchorage must be designed for an occupant weight of 170 pounds, considering the maximum load factors, inertia forces, and reactions among the occupant, seat, safety belt, and harness for each relevant flight and ground load condition (including the emergency landing conditions prescribed in 525.561). In addition:

(1) The structural analysis and testing of the seats, berths, and their supporting structures may be determined by assuming that the critical load in the forward, sideward, downward, upward, and rearward directions (as determined from the prescribed flight, ground, and emergency landing conditions) acts separately or using selected combinations of loads if the required strength in each specified direction is substantiated The forward load factor need not be applied to safety belts for berths.

(2) Each pilot seat must be designed for the reactions resulting from the application of the pilot forces prescribed in 525.395.

(3) The inertia forces specified in 525.561 must be multiplied by a factor of 1.33 (instead of the fitting factor prescribed in 525.625) in determining the strength of the attachment of each seat to the structure and each belt or harness to the seat or structure.

(g) Each seat at a flight deck station must have a restraint system consisting of a combined safety belt and shoulder harness with a single-point release that permits the flight deck occupant, when seated with the restraint system fastened, to perform all of the occupant's necessary flight deck functions. There must be a means to secure each combined restraint system, when not in use, to prevent interference with the operation of the aeroplane and with rapid egress in an emergency.

(h) Each seat located in the passenger compartment and designated for use during take-off and landing by a flight attendant required by the operating rules of this chapter must be:

(1) Near a required floor level emergency exit, except that another location is acceptable if the emergency egress of passengers would be enhanced with that location. A flight attendant seat must be located adjacent to each Type A or B emergency exit. Other flight attendant seats must be evenly distributed among the required floor level emergency exits to the extent feasible.

(2) To the extent possible, without compromising proximity to a required floor level emergency exit, located to provide a direct view of the cabin area for which the flight attendant is responsible.

(3) Positioned so that the seat will not interfere with the use of a passageway or exit when the seat is not in use.

(4) Located to minimise the probability that occupants would suffer injury by being struck by items dislodged from service areas, stowage compartments, or service equipment.

(5) Either forward or rearward facing with an energy absorbing rest that is designed to support the arms, shoulders, head, and spine.

(6) Equipped with a restraint system consisting of a combined safety belt and shoulder harness unit with a single point release. There must be means to secure each restraint system when not in use to prevent interference with rapid egress in an emergency.

(i) Each safety belt must be equipped with a metal to metal latching device.

(j) If the seat backs do not provide a firm hand hold, there must be a hand grip or rail along each aisle to enable persons to steady themselves while using the aisles in moderately rough air.

(k) Each projecting object that would injure persons seated or moving about the aeroplane in normal flight must be padded.

(l) Each forward observer's seat required by the operating rules must be shown to be suitable for use in conducting the necessary en route inspection.

(Change 525-1 (89-01-01))
(Change 525-3 (91-11-01))
(Change 525-8)

525.787 *Stowage Compartments*

(a) Each compartment for the stowage of cargo, baggage, carry-on articles, and equipment (such as life rafts), and any other stowage compartment must be designed for its placarded maximum weight of contents and for the critical load distribution at the appropriate maximum load factors corresponding to the specified flight and ground load conditions, and to the emergency landing conditions of 525.561*(b)*, except that the forces specified in the emergency landing conditions need not be applied to the compartments located below, or forward, of all occupants in the aeroplane. If the aeroplane has a passenger seating configuration, excluding pilots seats, of 10 seats or more, each stowage compartment in the passenger cabin, except for underseat and overhead compartments for passenger convenience, must be completely enclosed.

(b) There must be a means to prevent the contents in the compartments from becoming a hazard by shifting, under the loads specified in paragraph *(a)* of this section. For stowage compartments in the passenger and crew cabin, if the means used is a latched door, the design must take into consideration the wear and deterioration expected in service.

(c) If cargo compartment lamps are installed, each lamp must be installed so as to prevent contact between lamp bulb and cargo.

525.789 *Retention of Items of Mass in Passenger and Crew Compartments and Galleys*

(a) Means must be provided to prevent each item of mass (that is part of the aeroplane type design) in a passenger or crew compartment or galley from becoming a hazard by shifting under the appropriate maximum load factors corresponding to the specified flight and ground load conditions, and to the emergency landing conditions of 525.561*(b)*.

(b) Each interphone restraint system must be designed so that when subjected to the load factors specified in 525.561*(b)*(3), the interphone will remain in its stowed position.

525.791 *Passenger Information Signs and Placards*

(a) If smoking is to be prohibited, there must be at least one placard so stating that is legible to each person seated in the cabin. If smoking is to be allowed, and if the crew compartment is separated from the passenger compartment, there must be at least one sign notifying when smoking is prohibited. Signs which notify when smoking is prohibited must be operable by a member of the flight crew and, when illuminated, must be legible under all probable conditions of cabin illumination to each person seated in the cabin.

(b) Signs that notify when seat belts should be fastened and that are installed to comply with the applicable operating rules of this chapter must be operable by a member of the flight crew and, when illuminated, must be legible under all probable conditions of cabin illumination to each person seated in the cabin.

(c) A placard must be located on or adjacent to the door of each receptacle used for the disposal of flammable waste materials to indicate that use of the receptacle for disposal of cigarettes, etc., is prohibited.

(d) Lavatories must have "No Smoking" or "No Smoking in Lavatory" placards conspicuously located on or adjacent to each side of the entry door.

(e) Symbols that clearly express the intent of the sign or placard may be used in lieu of letters.

(Change 525-3 (91-11-01)

525.793 *Floor Surfaces*

The floor surface of all areas which are likely to become wet in service must have slip resistant properties.

525.794 *Reserved*

(Change 525-8.1 (2002-03-21))

525.795 *Security Considerations*

(a) Protection of flight crew compartment
(amended 2010/06/16)

If a flight deck door is required by subsections 701.30(1) or 705.80(1) of the *Canadian Aviation Regulations*:
(amended 2010/06/16)

(1) The bulkhead, door and any other accessible boundary separating the flight crew compartment from occupied areas must be designed to resist forcible intrusion by unauthorized persons and be capable of withstanding impacts of 300 Joules (221.3 foot-pounds);
(amended 2010/06/16)

(2) The bulkhead, door and any other accessible boundary separating the flight crew compartment from occupied areas must be designed to resist a constant 250 pound (1113 Newtons) tensile load on accessible handholds, including the doorknob or handle;
(amended 2010/06/16)

(3) The bulkhead, door and any other boundary separating the flight crew compartment from any occupied areas must be designed to resist penetration by small arms fire and fragmentation devices to a level equivalent to level IIIa of the U.S. National Institute of Justice Standard, *NIJ Standard - 0101.04*.
(amended 2010/06/16)

(b) Aeroplanes with a maximum certificated passenger seating capacity of more than 60 persons or a maximum certificated take-off gross weight of over 100,000 pounds (45,359 Kilograms) must be designed to limit the effects of an explosive or incendiary device as follows:
(amended 2010/06/16)

(1) *Flight deck smoke protection.* Means must be provided to limit entry of smoke, fumes and noxious gases into the flight deck;

(2) *Passenger cabin smoke protection.* Means must be provided to prevent passenger incapacitation in the cabin resulting from smoke, fumes and noxious gases as represented by the initial combined volumetric concentrations of 0.59% carbon monoxide and 1.23% carbon dioxide;

(3) *Cargo compartment fire suppression.* An extinguishing agent must be capable of suppressing a fire. All cargo-compartment fire suppression systems must be designed to withstand the following effects, including support structure displacements or adjacent materials displacing against the distribution system:

(i) Impact or damage from a 0.5-inch diameter aluminum sphere traveling at 430 feet per second (131.1 metres per second);

(ii) A 15-pound per square-inch (103.4 kPa) pressure load if the projected surface area of the component is greater than 4 square feet. Any single dimension greater than 4 feet (1.22 metres) may be assumed to be 4 feet (1.22 metres) in length;

(iii) A 6-inch (0.152 metres) displacement, except where limited by the fuselage contour, from a single point force applied anywhere along the distribution system where relative movement between the system and its attachment can occur;

(iv) Subparagraphs (b)(3)(i) through (iii) of this section do not apply to components that are redundant and separated in accordance with paragraph (c)(2) of this section or are installed remotely from the cargo compartment.

(c) An aeroplane with a maximum certificated passenger seating capacity of more than 60 persons or a maximum certificated take-off gross weight of over 100,000 pounds (45,359 Kilograms) must comply with the following:
(amended 2010/06/16)

(1) *Least risk bomb location.* An aeroplane must be designed with a designated location where a bomb or other explosive device could be placed to best protect flight-critical structures and systems from damage in the case of detonation.

(2) *Survivability of systems.*

(i) Except where impracticable, redundant aeroplane systems necessary for continued safe flight and landing must be physically separated, at a minimum, by an amount equal to a sphere of diameter

$D = 2 \sqrt{(H_0 / \Pi)}$

(where H_0 is defined under 525.365(e)(2) and D need not exceed 5.05 feet (1.54 metres)). The sphere is applied everywhere within the fuselage limited by the forward bulkhead and the aft bulkhead of the passenger cabin and cargo compartment beyond which, only one-half the sphere is applied.

(ii) Where compliance with subparagraph (c)(2)(i) of this section is impracticable, other design precautions must be taken to maximize the survivability of those systems.

(3) *Interior design to facilitate searches.* Design features must be incorporated that will deter concealment or promote discovery of weapons, explosives or other objects from a simple inspection in the following areas of the aeroplane cabin:

(i) Areas above the overhead bins must be designed to prevent objects from being hidden from view in a simple search from the aisle. Designs that prevent concealment of objects with volumes 20 cubic inches and greater satisfy this requirement.

(ii) Toilets must be designed to prevent the passage of solid objects greater than 2.0 inches in diameter.

(iii) Life preservers or their storage locations must be designed so that tampering is evident.

(d) *Exceptions.* Aeroplanes used solely to transport cargo only need to meet the requirements of paragraphs (b)(1), (b)(3) and (c)(2) of this section.
(amended 2010/06/16)

(e) *Material Incorporated by Reference.* You must use National Institute of Justice, NIJ *Standard 0101.04*, Ballistic Resistance of Personal Body Armor, June 2001, Revision A, to establish ballistic resistance as required by paragraph (a)(3) of this section.
(amended 2010/06/16)

Information notes:
(amended 2010/06/16)

(i) You may review copies of NIJ Standard 0101.04 at the:

(A) FAA Transport Airplane Directorate, 1601 Lind Avenue, SW., Renton, Washington 98055;

(B) National Institute of Justice (NIJ), http://www.ojp.usdoj.gov/nij, telephone (202) 307–2942;

(C) National Archives and Records Administration (NARA). For information on the availability of this material at NARA go to http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html or call (202) 741–6030; or

(ii) You may obtain copies of NIJ Standard 0101.04 from the National Criminal Justice Reference Service, P.O. Box 6000, Rockville, MD 20849–6000, telephone (800) 851-3420.

Emergency Provisions

525.801 *Ditching*

(a) If certification with ditching provisions is requested, the aeroplane must meet the requirements of this section and 525.807*(e)*, 525.1411, and 525.1415*(a)*.

(b) Each practicable design measure, compatible with the general characteristics of the aeroplane, must be taken to minimise the probability that in an emergency landing on water, the behaviour of the aeroplane would cause immediate injury to the occupants or would make it impossible for them to escape.

(c) The probable behaviour of the aeroplane in a water landing must be investigated by model tests or by comparison with aeroplanes of similar configuration for which the ditching characteristics are known. Scoops, flaps, projections, and any other factor likely to affect the hydro-dynamic characteristics of the aeroplane, must be considered.

(d) It must be shown that, under reasonably probable water conditions, the flotation time and trim of the aeroplane will allow the occupants to leave the aeroplane and enter the life rafts required by 525.1415. If compliance with this provision is shown by buoyancy and trim computations, appropriate allowances must be made for probable structural damage and leakage. If the aeroplane has fuel tanks (with fuel jettisoning provisions) that can reasonably be expected to withstand a ditching without leakage, the jettisonable volume of fuel may be considered as buoyancy volume.

(e) Unless the effects of the collapse of external doors and windows are accounted for in the investigation of the probable behaviour of the aeroplane in a water landing (as prescribed in paragraphs *(c)* and *(d)* of this section), the external doors and windows must be designed to withstand the probable maximum local pressures.

(Change 525-3 (91-11-01))

525.803 *Emergency Evacuation*

(a) Each crew and passenger area must have emergency means to allow rapid evacuation in crash landings, with the landing gear extended as well as with the landing gear retracted, considering the possibility of the aeroplane being on fire.

(b) (Reserved)

(c) For aeroplanes having a seating capacity of more than 44 passengers, it must be shown that the maximum seating capacity, including the number of crew members required by the operating rules for which certification is requested, can be evacuated from the aeroplane to the ground under simulated emergency conditions within 90 seconds. Compliance with this requirement must be shown by actual demonstration using the test criteria outlined in Appendix J of this chapter unless the Minister finds that a combination of analysis and testing will provide data equivalent to that which would be obtained by actual demonstration.

(d) (Reserved)

(e) (Reserved)

(Change 525-3 (91-11-01))

525.805 *(Removed)*

(Change 525-3 (91-11-01))

525.807 *Emergency Exits*

(a) Type. For the purpose of this chapter, the types of exits are defined as follows:

(1) *Type I*. This type is a floor-level exit with a rectangular opening of not less than 24 inches wide by 48 inches high, with corner radii not greater than eight inches.

(2) *Type II*. This type is a rectangular opening of not less than 20 inches wide by 44 inches high, with corner radii not greater than seven inches. Type II exits shall be floor-level exits unless located over the wing, in which case they shall not have a step-up inside the aeroplane of more than 10 inches nor a step-down outside the aeroplane of more than

17 inches.
(amended 2007/03/08)

(3) *Type III*. This type is a rectangular opening of not less than 20 inches wide by 36 inches high with corner radii not greater than seven inches, and with a step-up inside the aeroplane of not more than 20 inches. If the exit is located over the wing, the step-down outside the aeroplane may not exceed 27 inches.

(4) *Type IV*. This type is a rectangular opening of not less than 19 inches wide by 26 inches high, with corner radii not greater than 6.3 inches, located over the wing, with a step-up inside the aeroplane of not more than 29 inches and a step-down outside the aeroplane of not more than 36 inches.

(5) *Ventral*. This type is an exit from the passenger compartment through the pressure shell and the bottom fuselage skin. The dimensions and physical configuration of this type of exit shall allow at least the same rate of egress as a Type I with the aeroplane in the normal ground attitude, with landing gear extended.
(amended 2007/03/08)

(6) *Tailcone*. This type is an aft exit from the passenger compartment through the pressure shell and through an openable cone of the fuselage aft of the pressure shell. The means of opening the tail cone shall be simple and obvious, and shall employ a single operation.
(amended 2007/03/08)

(7) *Type A*. This type is a floor-level exit with a rectangular opening of not less than 42 inches wide by 72 inches high, with corner radii not greater than seven inches.

(8) *Type B*. This type is a floor-level exit with a rectangular opening of not less than 32 inches wide by 72 inches high, with corner radii not greater than six inches.

(9) *Type C*. This type is a floor-level exit with a rectangular opening of not less than 30 inches wide by 48 inches high, with corner radii not greater than 10 inches.

(b) Step down distance. Step down distance, as used in this section, means the actual distance between the bottom of the required opening and a usable foot hold, extending out from the fuselage, that is large enough to be effective without searching by sight or feel.

(c) Over-sized exits. Openings larger that those specified in this section, whether or not of rectangular shape, may be used if the specified rectangular opening can be inscribed within the opening and the base of the inscribed rectangular opening meets the specified step-up and step-down heights.

(d) Asymmetry. Exits of an exit pair need not be diametrically opposite each other nor of the same size; however, the number of passenger seats permitted under paragraph *(g)* of this section is based on the smaller of the two exits.

(e) Uniformity. Exits shall be distributed as uniformly as practical, taking into account passenger seat distribution.
(amended 2007/03/08)

(f) Location.

(1) Each required passenger emergency exit shall be accessible to the passengers and located where it will afford the most effective means of passenger evacuation.
(amended 2007/03/08)

(2) If only one floor-level exit per side is prescribed, and the aeroplane does not have a tail-cone or ventral emergency exit, the floor-level exits shall be in the rearward part of the passenger compartment unless another location affords a more effective means of passenger evacuation.
(amended 2007/03/08)

(3) If more than one floor-level exit per side is prescribed, and the aeroplane does not have a combination cargo and passenger configuration, at least one floor-level exit shall be located in each side near each end of the cabin.
(amended 2007/03/08)

(4) For an aeroplane that is required to have more than one passenger emergency exit for each side of the fuselage, no passenger emergency exit shall be more than 60 feet from any adjacent passenger emergency exit on the same side of the same deck of the fuselage, as measured parallel to the aeroplane's longitudinal axis between the nearest exit edges.

(g) Type and number required. The maximum number of passenger seats permitted depends on the type and number of exits installed in each side of the fuselage. Except as further restricted in *(g)*(1) through *(g)*(9) of this section, the maximum number of passenger seats permitted for each exit of a specific type installed in each side of the fuselage is as follows:
(amended 2007/03/08)

Type A	110
Type B	75
Type C	55
Type I	45
Type II	40
Type III	35
Type IV	9

(1) For a passenger seating configuration of 1 to 9 seats, there shall be at least one Type IV or larger overwing exit in each side of the fuselage or, if overwing exits are not provided, at least one exit in each side that meets the minimum dimensions of a Type III exit.
(amended 2007/03/08)

(2) For a passenger seating configuration of more than 9 seats, each exit shall be a Type III or larger exit.
(amended 2007/03/08)

(3) For a passenger seating configuration of 10 to 19 seats, there shall be at least one Type III or larger exit in each side of the fuselage.
(amended 2007/03/08)

(4) For a passenger seating configuration of 20 to 40 seats, there shall be at least two exits, one of which must be a Type II or larger exit, in each side of the fuselage.
(amended 2007/03/08)

(5) For a passenger seating configuration of 41 to 110 seats, there shall be at least two exits, one of which must be a Type I or larger exit, in each side of the fuselage.
(amended 2007/03/08)

(6) For a passenger seating configuration of more than 110 seats, the emergency exits in each side of the fuselage shall include at least two Type I or larger exits.
(amended 2007/03/08)

(7) The combined maximum number of passenger seats permitted for all Type III exits is 70, and the combined maximum number of passenger seats permitted for two Type III exits in each side of the fuselage that are separated by fewer than three passenger seat rows is 65.

(8) If a Type A, Type B, or Type C exit is installed, there shall be at least two Type C or larger exits in each side of the fuselage.
(amended 2007/03/08)

(9) If a passenger ventral or tail cone exit is installed and that exit provides at least the same rate of egress as a Type III exit with the aeroplane in the most adverse exit opening condition that would result from the collapse of one or more legs of the landing gear, an increase in the passenger seating configuration is permitted as follows:

(i) For a ventral exit, 12 additional passenger seats.

(ii) For a tail cone exit incorporating a floor level opening of not less than 20 inches wide by 60 inches high, with corner radii not greater than seven inches, in the pressure shell and incorporating an approved assist means in accordance with 525.810(a), 25 additional passenger seats.
(amended 2007/03/08)

(iii) For a tail cone exit incorporating an opening in the pressure shell which is at least equivalent to a Type III emergency exit with respect to dimensions, step-up and step-down distance, and with the top of the opening not less than 56 inches from the passenger compartment floor, 15 additional passenger seats.

(h) Other exits. The following exits also shall meet the applicable emergency exit requirements of 525.809 through 525.812, and shall be readily accessible:
(amended 2007/03/08)

(1) Each emergency exit in the passenger compartment in excess of the minimum number of required emergency exits.
(amended 2007/03/08)

(2) Any other floor-level door or exit that is accessible from the passenger compartment and is as large or larger than a Type II exit, but less than 46 inches wide.
(amended 2007/03/08)

(3) Any other ventral or tail cone passenger exit.
(amended 2007/03/08)

(i) Ditching emergency exits for passengers. Whether or not ditching certification is requested, ditching emergency exits shall be provided in accordance with the following requirements, unless the emergency exits required by *(g)* of this section already meet them: (amended 2007/03/08)

(1) For aeroplanes that have a passenger seating configuration of nine or fewer seats, excluding pilot seats, one exit above the waterline in each side of the aeroplane, meeting at least the dimensions of a Type IV exit.

(2) For aeroplanes that have a passenger seating configuration of 10 or more seats, excluding pilot seats, one exit above the waterline in a side of the aeroplane, meeting at least the dimensions of a Type III exit for each unit (or part of a unit) of 35 passenger seats, but no less than two such exits in the passenger cabin, with one on each side of the aeroplane. The passenger seat/ exit ratio may be increased through the use of larger exits, or other means, provided it is demonstrated that the evacuation capability during ditching has been improved accordingly.
(amended 2007/03/08)

(3) If it is impractical to locate side exits above the waterline, the side exits shall be replaced by an equal number of readily accessible overhead hatches of not less than the dimensions of a Type III exit, except that for aeroplanes with a passenger configuration of 35 or fewer seats, excluding pilot seats, the two required Type III side exits need be replaced by only one overhead hatch.
(amended 2007/03/08)

(j) Flight crew emergency exits. For aeroplanes in which the proximity of passenger emergency exits to the flight crew area does not offer a convenient and readily accessible means of evacuation of the flight crew, and for all aeroplanes having a passenger seating capacity greater than 20, flight crew exits shall be located int eh flight crew area. Such exits shall be of sufficient size and so located as to permit rapid evacuation by the crew. One exit shall be provided on each side of the aeroplane; or, alternatively, a top hatch shall be provided. Each exit shall encompass an unobstructed rectangular opening of at least 19 by 20 inches unless satisfactory exit utility can be demonstrated by a typical crew member.
(amended 2007/03/08)

(Change 525-3 (91-11-01))
(Change 525-8)

525.809 *Emergency Exit Arrangement*

(a) Each emergency exit, including a flight crew emergency exit, shall be a movable door or hatch in the external walls of the fuselage, allowing unobstructed opening to the outside. In addition, each emergency exit shall have a means to permit viewing of the conditions outside the exit when the exit is closed. The viewing means may be on or adjacent to the exit provided no obstructions exist between the exit and the viewing means. Means shall also be provided to permit viewing of the likely areas of evacuee ground contact. The likely areas of evacuee ground contact shall be viewable during all lighting conditions with the landing gear extended as well as in all conditions of landing gear collapse.
(amended 2007/03/08)

(b) Each emergency exit shall be openable from the inside and the outside except that sliding window emergency exits in the flight crew area need not be openable from the outside

if other approved exits are convenient and readily accessible to the flight crew area. Each emergency exit shall be capable of being opened, when there is no fuselage deformation:
(amended 2007/03/08)

(1) With the aeroplane in the normal ground attitude and in each of the attitudes corresponding to collapse of one or more legs of the landing gear;
(amended 2007/03/08)

(2) Within 10 seconds measured from the time when the opening means is actuated to the time when the exit is fully opened; and
(amended 2007/03/08)

(3) Even though persons may be crowded against the door on the inside of the aeroplane.
(amended 2007/03/08)

(c) The means of opening emergency exits shall be simple and obvious; may not require exceptional effort; and shall be arranged and marked so that it can be readily located and operated, even in the darkness. Internal exit-opening means involving sequence operations (such as operation of two handles or latches or the release of safety catches) may be used for flight crew emergency exits if it can be reasonably established that these means are simple and obvious to crew members trained in their use.
(amended 2007/03/08)

(d) If a single power-boost or single power-operated system is the primary system for operating more than one exit in an emergency, each exit shall be capable of meeting the requirements of *(b)* of this section in the event of failure of the primary system. Manual operation of the exit (after failure of the primary system) is acceptable.
(amended 2007/03/08)

(e) Each emergency exit shall be demonstrated by tests, or by a combination of analysis and tests, to meet the requirements of *(b)* and *(c)* of this section.
(amended 2007/03/08)

(f) Each door shall be located where persons using them will not be endangered by the propellers when appropriate operating procedures are used.
(amended 2007/03/08)

(g) There shall be provisions to minimize the probability of jamming of the emergency exits resulting from fuselage deformation in a minor crash landing.
(amended 2007/03/08)

(h) When required by the operating rules for any large passenger-carrying turbojet-powered aeroplane, each ventral exit and tailcone exit shall be:
(amended 2007/03/08)

(1) Designed and constructed so that it cannot be opened during flight; and

(2) Marked with a placard readable from a distance of 30 inches and installed at a conspicuous location near the means of opening the exit, stating that the exit has been designed and constructed so that it cannot be opened during flight.

(i) Each emergency exit shall have a means to retain the exit in the open position, once the exit is opened in an emergency. The means shall not require separate action to

engage when the exit is opened, and shall require positive action to disengage.
(amended 2007/03/08)

(Change 525-3 (91-11-01))

525.810 *Emergency Egress Assist Means and Escape Routes*

(a) Each non over-wing Type A, Type B or Type C exit, and any other non over-wing landplane emergency exit more than 6 feet from the ground with the aeroplane on the ground and the landing gear extended, shall have an approved means to assist the occupants in descending to the ground.
(amended 2007/03/08)

(1) The assisting means for each passenger emergency exit shall be a self-supporting slide or equivalent; and, in the case of Type A or Type B exits, it shall be capable of carrying simultaneously two parallel lines of evacuees. In addition, the assisting means shall be designed to meet the following requirements:
(amended 2007/03/08)

(i) It shall be automatically deployed and deployment shall begin during the interval between the time the exit opening means is actuated from inside the aeroplane and the time the exit is fully opened. However, each passenger emergency exit which is also a passenger entrance door or a service door shall be provided with means to prevent deployment of the assisting means when it is opened from either the inside or the outside under non-emergency conditions for normal use.
(amended 2007/03/08)

(ii) Except for assisting means installed at Type C exits, it shall be automatically erected within 6 seconds after deployment is begun. Assisting means installed at Type C exits shall be automatically erected within 10 seconds from the time the opening means of the exit is actuated.
(amended 2007/03/08)

(iii) It shall be of such length after full deployment that the lower end is self-supporting on the ground and provides safe evacuation of occupants to the ground after collapse of one or more legs of the landing gear.
(amended 2007/03/08)

(iv) It shall have the capability, in 25 knot winds directed from the most critical angle, to deploy and, with the assistance of only one person to remain usable after full deployment to evacuate occupants safely to the ground.
(amended 2007/03/08)

(v) For each system installation (mock-up or aeroplane installed), five consecutive deployment and inflation tests shall be conducted (per exit) without failure, and at least three tests of each such five-test series shall be conducted using a single representative sample of the device. The sample devices must be deployed and inflated by the system's primary means after being subjected to the inertia forces specified in 525.561(b). If any part of the system fails or does not function properly

during the required test, the cause of the failure or malfunction shall be corrected by positive means and after that, the full series of five consecutive deployment and inflation tests shall be conducted without failure.
(amended 2007/03/08)

(2) The assisting means for flight crew emergency exits may be a rope or any other means demonstrated to be suitable for the purpose. If the assisting means is a rope, or an approved device equivalent to a rope, it shall be:
(amended 2007/03/08)

(i) Attached to the fuselage structure at or above the top of the emergency exit opening, or, for a device at a pilot's emergency exit window, at another approved location if the stowed device, or its attachment, would reduce the pilot's view in flight:

(ii) Able (with its attachment) to withstand a 400-pound static load.

(b) Assist means from the cabin to the wing are required for each Type A or Type B exit located above the wing and having a step-down unless the exit without an assist-means can be shown to have a rate of passenger egress at least equal to that of the same type of non over-wing exit. If an assist means is required, it shall be automatically deployed and automatically erected concurrent with the opening of the exit. In the case of assist means installed at Type C exits, it shall be self-supporting within 10 seconds from the time the opening means of the exits is actuated. For all other exit types, it shall be self-supporting 6 seconds after deployment is begun.
(amended 2007/03/08)

(c) An escape route shall be established from each overwing emergency exit, and (except for flap surfaces suitable as slides) covered with a slip resistant surface. Except where a means for channelling the flow of evacuees is provided:
(amended 2007/03/08)

(1) The escape route from each Type A or Type B passenger emergency exit, or any common escape route from two Type III passenger emergency exits, shall be at least 42 inches wide; that from any other passenger emergency exit shall be at least 24 inches wide; and
(amended 2007/03/08)

(2) The escape route surface shall have a reflectance of at least 80 percent, and shall be defined by markings with a surface-to-marking contrast ratio of at least 5:1.
(amended 2007/03/08)

(d) Means shall be provided to assist evacuees to reach the ground for all Type C exits located over the wing and, if the place on the aeroplane structure at which the escape route required in *(c)* of this section terminates is more than 6 feet from the ground with the aeroplane on the ground and the landing gear extended, for all other exit types.
(amended 2007/03/08)

(1) If the escape route is over the flap, the height of the terminal edge shall be measured with the flap in the take-off or landing position, whichever is higher from the ground.
(amended 2007/03/08)

(2) The assisting means shall be usable and self-supporting with one or more landing gear legs collapsed and under a 25-knot wind directed from the most critical angle.
(amended 2007/03/08)

(3) The assisting means provided for each escape route leading from a Type A or B emergency exit shall be capable of carrying simultaneously two parallel lines of evacuees; and, the assisting means leading from any other exit type shall be capable of carrying as many parallel lines of evacuees as there are required escape routes.
(amended 2007/03/08)

(4) The assisting means provided for each escape route leading from a Type C exit shall be automatically erected within 10 seconds from the time the opening means of the exit is actuated, and that provided for the escape route leading from any other exit type must be automatically erected within 10 seconds after actuation of the erection system.
(amended 2007/03/08)

(e) If an integral stair is installed in a passenger entry door that is qualified as a passenger emergency exit, the stair shall be designed so that, under the following conditions, the effectiveness of passenger emergency egress will not be impaired:
(amended 2007/03/08)

(1) The door, integral stair, and operating mechanism have been subjected to the inertia forces specified in 525.561(b)(3), acting separately relative to the surrounding structure.
(amended 2007/03/08)

(2) The aeroplane is in the normal ground attitude and in each of the attitudes corresponding to collapse of one or more legs of the landing gear.
(amended 2007/03/08)

(Change 525-3 (91-11-01))
(Change 525-8)

525.811 *Emergency Exit Marking*

(a) Each passenger emergency exit, its means of access, and its means of opening must be conspicuously marked.

(b) The identity and location of each passenger emergency exit must be recognisable from a distance equal to the width of the cabin.

(c) Means must be provided to assist the occupants in locating the exits in conditions of dense smoke.

(d) The location of each passenger emergency exit must be indicated by a sign visible to occupants approaching along the main passenger aisle (or aisles). There must be:

(1) A passenger emergency exit locator sign above the aisle (or aisles) near each passenger emergency exit, or at another overhead location if it is more practical because of low headroom, except that one sign may serve more than one exit if each exit can be seen readily from the sign;

(2) A passenger emergency exit marking sign next to each passenger emergency exit, except that one sign may serve two such exits if they both can be seen readily from the sign; and

(3) A sign on each bulkhead or divider that prevents fore and aft vision along the passenger cabin to indicate emergency exits beyond and obscured by the bulkhead or divider, except that if this is not possible the sign may be placed at another appropriate location.

(e) The location of the operating handle and instructions for opening exits from the inside of the aeroplane must be shown in the following manner:

(1) Each passenger emergency exit must have, on or near the exit, a marking that is readable from a distance of 30 inches.

(2) Each Type A, Type B, Type C or Type I passenger emergency exit operating handle must:

(i) Be self-illuminated with an initial brightness of at least 160 microlamberts; or

(ii) Be conspicuously located and well illuminated by the emergency lighting even in conditions of occupant crowding at the exit.

(3) (Reserved)

(4) Each Type A, Type B, Type C, Type I, or Type II passenger emergency exit with a locking mechanism released by rotary motion of the handle must be marked:

(i) With a red arrow, with a shaft at least three-fourths of an inch wide and a head twice the width of the shaft, extending along at least 70 degrees of arc at a radius approximately equal to three-fourths of the handle length.

(ii) So that the centreline of the exit handle is within $\pm$ 1 inch of the projected point of the arrow when the handle has reached full travel and has released the locking mechanism, and

(iii) With the word "open" in red letters 1 inch high, placed horizontally near the head of the arrow.

(f) Each emergency exit that is required to be openable from the outside, and its means of opening, must be marked on the outside of the aeroplane. In addition, the following apply:

(1) The outside marking for each passenger emergency exit in the side of the fuselage must include a 2-inch coloured band outlining the exit.

(2) Each outside marking including the band, must have colour contrast to be readily distinguishable from the surrounding fuselage surface. The contrast must be such that if the reflectance of the darker colour is 15 percent or less, the reflectance of the lighter colour must be at least 45 percent. "Reflectance" is the ratio of the luminous flux reflected by a body to the luminous flux it receives. When the reflectance of the darker colour is greater than 15 percent, at least a 30 percent difference between its reflectance and the reflectance of the lighter colour must be provided.

(3) In the case of exits other than those in the side of the fuselage, such as ventral or tail cone exits, the external means of opening, including instructions if applicable, must be

conspicuously marked in red, or bright chrome yellow if the background colour is such that red is inconspicuous. When the opening means is located on only one side of the fuselage, a conspicuous marking to that effect must be provided on the other side.

(g) Each sign required by paragraph *(d)* of this section may use the word "exit" in its legend in the place of the term "emergency exit".

(Change 525-3 (91-11-01))
(Change 525-6 (93-12-30))
(Change 525-8)

525.812 *Emergency Lighting*

(a) An emergency lighting system, independent of the main lighting system, must be installed. However, the sources of general cabin illumination may be common to both the emergency and the main lighting systems if the power supply to the emergency lighting system is independent of the power supply to the main lighting system. The emergency lighting system must include:

(1) Illuminated emergency exit marking and locating signs, sources of general cabin illumination, interior lighting in emergency exit areas, and floor proximity escape path marking.

(2) Exterior emergency lighting.

(b) Emergency exit signs:

(1) For aeroplanes that have a passenger seating configuration, excluding pilot seats, of 10 seats or more must meet the following requirements:

(i) Each passenger emergency exit locator sign required by 525.811(d)(1) and each passenger emergency exit marking sign required by 525.811(d)(2) must have red letters at least 1½ inches high on an illuminated white background, and must have an area of at least 21 square inches excluding the letters. The lighted background-to-letter contrast must be at least 10:1. The letter height to stroke-width ratio may not be more than 7:1 nor less than 6:1. These signs must be internally electrically illuminated with a background brightness of at least 25 foot-lamberts and a high-to-low background contrast no greater than 3:1.

(ii) Each passenger emergency exit sign required by 525.811(d)(3) must have red letters at least 1½ inches high on a white background having an area of at least 21 square inches excluding the letters. These signs must be internally electrically illuminated or self-illuminated by other than electrical means and must have an initial brightness of at least 400 microlamberts. The colours may be reversed in the case of a sign that is self-illuminated by other than electrical means.

(2) For aeroplanes that have a passenger seating configuration, excluding pilot seats, of nine seats or less, that are required by 525.811(d)(1), (2) and (3) must have red letters at least 1 inch high on a white background at least 2 inches high. These signs may be internally electrically illuminated, or self-illuminated by other than electrical means, with an initial brightness of at least 160 microlamberts. The colours may be reversed in the case of a sign that is self-illuminated by other than electrical means.

(c) General illumination in the passenger cabin must be provided so that when measured along the centreline of main passenger aisle(s), and cross aisle(s) between main aisles, at seat armrest height and at 40-inch intervals, the average illumination is not less than 0.05 foot-candle and the illumination at each 40-inch interval is not less than 0.01 foot-candle. A main passenger aisle(s) is considered to extend along the fuselage from the most forward passenger emergency exit or cabin occupant seat, whichever is farther forward, to the most rearward passenger emergency exit or cabin occupant seat, whichever is farther aft.

(d) The floor of the passageway leading to each floor-level passenger emergency exit, between the main aisles and the exit openings, must be provided with illumination that is not less than 0.02 foot-candle measured along a line that is within 6 inches of and parallel to the floor and is centred on the passenger evacuation path.

(e) Floor proximity emergency escape path markings must provide emergency evacuation guidance for passengers when all sources of illumination more than 4 feet above the cabin aisle floor are totally obscured. In the dark of the night, the floor proximity emergency escape path markings must enable each passenger to:

(1) After leaving the passenger seat visually identify the emergency escape path along the cabin aisle floor to the first exits or pair of exits forward and aft of the seat; and

(2) Readily identify each exit from the emergency escape path by reference only to markings and visual features not more than 4 feet above the cabin floor.

(f) Except for subsystems provided in accordance with paragraph *(h)* of this section that serve no more than one assist means, are independent of the aeroplane's main emergency lighting system, and are automatically activated when the assist means is erected, the emergency lighting system must be designed as follows:

(1) The lights must be operable manually from the flight crew station and from a point in the passenger compartment that is readily accessible to a normal flight attendant seat.

(2) There must be a flight crew warning light which illuminates when power is on in the aeroplane and the emergency lighting control device is not armed.

(3) The cockpit control device must have an "on," "off," and "armed" position so that when armed in the cockpit or turned on at either the cockpit or flight attendant station the lights will either light or remain lighted upon interruption (except an interruption caused by a transverse vertical separation of the fuselage during crash landing) of the aeroplane's normal electric power. There must be a means to safeguard against inadvertent operation of the control device from the "armed" or "on" positions.

(g) Exterior emergency lighting must be provided as follows:

(1) At each overwing emergency exit the illumination shall be:
(amended 2007/03/08)

(i) Not less than 0.03 foot-candle (measured normal to the direction of the incident light) on a 2-square-foot area where an evacuee is likely to make his first step outside the cabin;

(ii) Not less than 0.05 foot-candle (measured normal to the direction of incident light) for a minimum width of 42 inches for a Type A over wing emergency exit and two feet for all other over wing emergency exits along the 30 percent of the slip-resistant portion of the escape route required in 525.810(c) that is farthest from the exit; and
(amended 2007/03/08)

(iii) Not less than 0.03 foot-candle on the ground surface with the landing gear extended (measured normal to the direction of the incident light) where an evacuee using the established escape route would normally make first contact with the ground.

(2) At each non-overwing emergency exit not required by 525.810(a) to have descent assist means, the illumination shall be not less than 0.03 foot-candle (measured normal to the direction of the incident light) on the ground surface with the landing gear extended where an evacuee is likely to make his first contact with the ground outside the cabin.
(amended 2007/03/08)

(h) The means required in 525.810*(a)(1)* and *(d)* to assist the occupants in descending to the ground must be illuminated so that the erected assist means is visible from the aeroplane. In addition:
(amended 2012/03/27)

(1) If the assist means is illuminated by exterior emergency lighting, it must provide illumination of not less than 0.03 foot-candle (measured normal to the direction of the incident light) at the ground end of the erected assist means where an evacuee using the established escape route would normally make first contact with the ground, with the aeroplane in each of the attitudes corresponding to the collapse of one or more legs of the landing gear.

(2) If the emergency lighting subsystem illuminating the assist means serves no other assist means, is independent of the aeroplane's main emergency lighting system, and is automatically activated when the assist means is erected, the lighting provisions:

(i) May not be adversely affected by stowage; and

(ii) Must provide illumination of not less than 0.03 foot-candle (measured normal to the direction of incident light) at the ground end of the erected assist means where an evacuee would normally make first contact with the ground, with the aeroplane in each of the attitudes corresponding to the collapse of one or more legs of the landing gear.

(i) The energy supply to each emergency lighting unit must provide the required level of illumination for at least 10 minutes at the critical ambient conditions after emergency landing.

(j) If storage batteries are used as the energy supply for the emergency lighting system, they may be recharged from the aeroplane's main electric power system, provided, that, the charging circuit is designed to preclude inadvertent battery discharge into charging circuit faults.

(k) Components of the emergency lighting system, including batteries, wiring relays, lamps, and switches must be capable of normal operation after having been subjected to the inertia forces listed in 525.561*(b)*.

(l) The emergency lighting system must be designed so that after any single transverse vertical separation of the fuselage during crash landing:

(1) Not more than 25 percent of all electrically illuminated emergency lights required by this section are rendered inoperative, in addition to the lights that are directly damaged by the separation;

(2) Each electrically illuminated exit sign required under 525.811(d)(2) remains operative exclusive of those that are directly damaged by the separation; and

(3) At least one required exterior emergency light for each side of the aeroplane remains operative exclusive of those that are directly damaged by the separation.

(Change 525-8)

525.813 *Emergency Exit Access*

Each required emergency exit must be accessible to the passengers and located where it will afford an effective means of evacuation. Emergency exit distribution must be as uniform as practical, taking passenger distribution into account; however, the size and location of exits on both sides of the cabin need not be symmetrical. If only one floor level exit per side is prescribed, and the aeroplane does not have a tail cone or ventral emergency exit, the floor level exit must be in the rearward part of the passenger compartment, unless another location affords a more effective means of passenger evacuation. Where more than one floor level exit per side is prescribed, at least one floor level exit per side must be located near each end of the cabin, except that this provision does not apply to combination cargo/passenger configurations. In addition:

(a) There must be a passageway leading from the nearest main aisle to each Type A, Type B, Type C, Type I, or Type II emergency exit and between individual passenger areas. Each passageway leading to a Type A or Type B exit must be unobstructed and at least 36 inches wide. Passageways between individual passenger areas and those leading to Type I, Type II, or Type C emergency exits must be unobstructed and at least 20 inches wide. Unless there are two or more main aisles, each Type A or B exit must be located so that there is passenger flow along the main aisle to that exit from both the forward and aft directions. If two or more main aisles are provided, there must be unobstructed cross-aisles at least 20 inches wide between main aisles. There must be:

(1) A cross-aisle which leads directly to each passageway between the nearest main aisle and a Type A or B exit; and

(2) A cross-aisle which leads to the immediate vicinity of each passageway between the nearest main aisle and a Type I, Type II, or Type III exit; except that when two Type III exits are located within three passenger rows of each other, a single cross-aisle may be used if it leads to the vicinity between the passageways from the nearest main aisle to each exit.

(b) Adequate space to allow crew member(s) to assist in the evacuation of passengers shall be provided as follows:
(amended 2007/03/08)

(1) Each assist space shall be a rectangle on the floor, of sufficient size to enable a crew member, standing erect, to effectively assist evacuees. The assist space shall not reduce the unobstructed width of the passageway below that required for the exit.
(amended 2007/03/08)

(2) For each Type A or Type B exit, assist space shall be provided at each side of the exit regardless of whether a means is required by 525.810(a).
(amended 2007/03/08)

(3) For each Type C, I or II exit installed in an aeroplane with seating for more than 80 passengers, an assist space shall be provided at one side of the passageway regardless of whether an assist means is required by 525.810(a).
(amended 2007/03/08)

(4) For each Type C, I or II exit, an assist space shall be provided at one side of the passageway if an assist means is required by 525.810(a).
(amended 2007/03/08)

(5) For any tail cone exit that qualifies for 25 additional passenger seats under the provisions of 525.807(g)(9)(ii), an assist space shall be provided, if an assist means is required by 525.810(a).
(amended 2007/03/08)

(6) There shall be a handle, or handles, at each assist space, located to enable the crew member to steady himself or herself:
(amended 2007/03/08)

(i) While manually activating the assist means (where applicable) and,
(amended 2007/03/08)

(ii) While assisting passengers during an evacuation.
(amended 2007/03/08)

(c) The following must be provided for each Type III or Type IV exit:

(1) There must be access from the nearest main aisle to each exit. In addition, for each Type III exit in an aeroplane that has a passenger seating configuration of 60 or more:

(i) Except as provided in paragraph (c)(1)(ii), the access must be provided by an unobstructed passageway that is at least 10 inches in width for interior arrangements in which the adjacent seat rows on the exit side of the aisle contain no more than two seats, or 20 inches in width for interior arrangements in which those rows contain three seats. The width of the passageway must be measured with adjacent seats adjusted to their most adverse position. The centreline of the required passageway width must not be displaced more than 5 inches horizontally from that of the exit.

(ii) In lieu of one 10 or 20-inch passageway, there may be two passageways, between seat rows only, that must be at least 6 inches in width and lead to an unobstructed space adjacent to each exit. (Adjacent exits must not share a common passageway.) The width of the passageways must be measured with adjacent seats adjusted to their most adverse position. The unobstructed space adjacent to the exit must extend vertically from the floor to the ceiling (or bottom of sidewall stowage bins), inboard from the exit for a distance not less than the width of the narrowest passenger seat installed on the aeroplane, and from the forward edge of the forward passageway to the aft edge of the aft passageway. The exit opening must be totally in the fore and aft bounds of the unobstructed space.

(2) In addition to the access:

(i) For aeroplanes that have a passenger seating configuration of 20 or more, the projected opening of the exit provided must not be obstructed and there must be no interference in opening the exit by seats, berths, or other protrusions (including any seat back in the most adverse position) for a distance from that exit not less than the width of the narrowest passenger seat installed on the aeroplane.

(ii) or aeroplanes that have a passenger seating configuration of 19 or fewer, there may be minor obstructions in this region, if there are compensating factors to maintain the effectiveness of the exit.

(3) For each Type III exit, regardless of the passenger capacity of the aeroplane in which it is installed, there must be placards that:

(i) Are readable by all persons seated adjacent to and facing a passageway to the exit;

(ii) Accurately state or illustrate the proper method of opening the exit, including the use of handholds; and

(iii) If the exit is a removable hatch, state the weight of the hatch and indicate an appropriate location to place the hatch after removal.

(d) If it is necessary to pass through a passageway between passenger compartments to reach any required emergency exit from any seat in the passenger cabin, the passageway must be unobstructed. However, curtains may be used if they allow free entry through the passageway.

(e) No door may be installed between any passenger seat that is occupiable for takeoff and landing and any passenger emergency exit, such that the door crosses any egress path (including aisles, cross aisles and passageways).
(amended 2007/03/08)

(f) If it is necessary to pass through a doorway separating any crew member seat (except those seats on the flight deck), occupiable for takeoff and landing, from any emergency exit, the door shall have a means to latch it in open position. The latching means shall be able to withstand the loads imposed upon it when the door is subjected to the ultimate inertia forces, relative to the surrounding structure, listed in 525.561*(b)*.
(amended 2007/03/08)

(Change 525-3 (91-11-01))
(Change 525-5 (92-10-30))
(Change 525-8)

525.815 *Width of Aisle*

The passenger aisle width at any point between seats must equal or exceed the values in the following table:

Passenger seating capacity	Minimum passenger aisle width (inches)	
	Less than 25 in. from floor	25 in. and more from floor
10 or less	[1]12	15
11 through 19	12	20
20 or more	15	20
[1]A narrower width not less than 9 inches may be approved when substantiated by tests found necessary by the Minister		

525.817 *Maximum Number of Seats Abreast*

On aeroplanes having only one passenger aisle, no more than three seats abreast may be placed on each side of the aisle in any one row.

525.819 *Lower Deck Service Compartments (Including Galleys)*

For aeroplanes with a service compartment located below the main deck, which may be occupied during taxi or flight but not during take-off or landing, the following apply:

(a) There must be at least two emergency evacuation routes, one at each end of lower deck service compartment or two having sufficient separation within each compartment, which could be used by each occupant or the lower deck service compartment to rapidly evacuate to the main deck under normal and emergency lighting conditions. The routes must provide for the evacuation of incapacitated persons, with assistance. The use of the evacuation routes may not be dependent on any powered device. The routes must be designed to minimise the possibility of blockage which might result from fire, mechanical or structural failure, or persons standing on top of or against the escape routes. In the event the aeroplane's main power system or compartment main lighting system should fail, emergency illumination for each lower deck service compartment must be automatically provided.

(b) There must be a means for two-way voice communication between the flight deck and each lower deck service compartment, which remains available following loss of normal electrical power generating system.
(amended 2003/11/30)

(c) There must be an aural emergency alarm system, audible during normal and emergency conditions, to enable crew members on the flight deck and at each required floor level emergency exit to alert occupants of each lower deck service compartment of an emergency situation.

(d) There must be a means, readily detectable by occupants of each lower deck service compartment, that indicates when seat belts should be fastened.

(e) If a public address system is installed in the aeroplane, speakers must be provided in each lower deck service compartment.

(f) For each occupant permitted in a lower deck service compartment, there must be a forward or aft facing seat which meets the requirements of 525.785*(d)* and must be able to withstand maximum flight loads when occupied.
(amended 2003/11/30)

(g) For each powered lift system installed between a lower deck service compartment and the main deck for the carriage of persons or equipment, or both, the system must meet the following requirements:

(1) Each lift control switch outside the lift, except emergency stop buttons, must be designed to prevent the activation of the lift if the lift door, or the hatch required by paragraph (g)(3) of this section, or both are open.

(2) An emergency stop button, that when activated will immediately stop the lift, must be installed within the lift and at each entrance to the lift.

(3) There must be a hatch capable of being used for evacuating persons from the lift that is openable from inside and outside the lift without tools, with the lift in any position.

525.820 *Lavatory Doors*

(amended 2007/03/08)

All lavatory doors shall be designed to preclude anyone from becoming trapped inside the lavatory. If a locking mechanism is installed, it shall be capable of being unlocked from the outside without the aid of special tools.
(amended 2007/03/08)

Ventilation and Heating

525.831 *Ventilation*

(a) Under normal operating conditions and in the event of any probable failure conditions of any system which would adversely affect the ventilating air, the ventilation system must be designed to provide a sufficient amount of uncontaminated air to enable the crew-members to perform their duties without undue discomfort or fatigue and to provide reasonable passenger comfort. For normal operating conditions, the ventilation system must be designed to provide each occupant with an airflow containing at least 0.55 pounds of fresh air per minute.

(b) Crew and passenger compartment air must be free from harmful or hazardous concentrations of gases or vapours. In meeting this requirement, the following apply:

(1) Carbon monoxide concentrations in excess of one part in 20,000 parts of air are considered hazardous. For test purposes, any acceptable carbon monoxide detection method may be used.

(2) Carbon dioxide concentration during flight must be shown not to exceed 0.5 percent by volume (sea level equivalent) in compartments normally occupied by passengers or crew members.

(c) There must be provisions made to ensure that the conditions prescribed in paragraph *(b)* of this section are met after reasonably probable failures or malfunctioning of the ventilating, heating, pressurisation, or other systems and equipment.

(d) If accumulation of hazardous quantities of smoke in the cockpit area is reasonably probable, smoke evacuation must be readily accomplished, starting with full pressurisation and without depressurising beyond safe limits.

(e) Except as provided in paragraph *(f)* of this section, means must be provided to enable the occupants of the following compartments and areas to control the temperature and quantity of ventilating air supplied to their compartment or area independently of the temperature and quantity of air supplied to other compartments and areas:

(1) The flight crew compartment.

(2) Crew member compartments and areas other than the flight crew compartment unless the crew member compartment or area is ventilated by air interchange with other compartments or areas under all operating conditions.

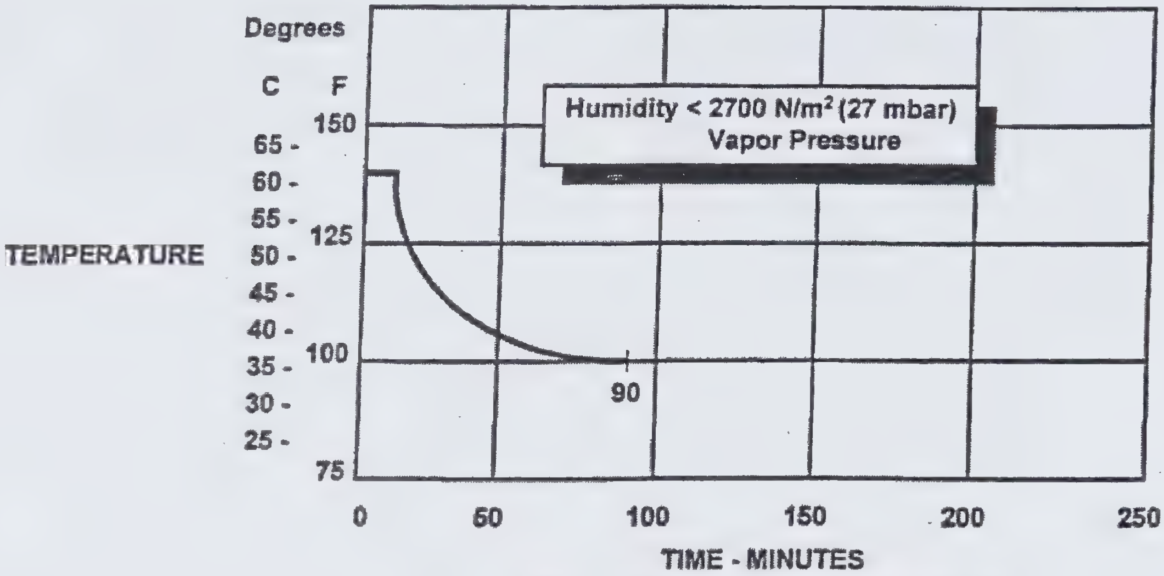
(f) Means to enable the flight crew to control the temperature and quantity of ventilating air supplied to the flight crew compartment independently of the temperature and quantity of ventilating air supplied to other compartments are not required if all of the following conditions are met:

(1) The total volume of the flight crew and passenger compartments is 800 cubic feet or less.

(2) The air inlets and passages for air to flow between flight crew and passenger compartments are arranged to provide compartment temperatures within 5 degrees F. of each other and adequate ventilation to occupants in both compartments.

(3) The temperature and ventilation controls are accessible to the flight crew.

(g) The exposure time at any given temperature must not exceed the values shown in the following graph after any improbable failure condition.



TIME - TEMPERATURE RELATIONSHIP

(Change 525-8)

525.832 *Cabin Ozone Concentration*

(a) The aeroplane cabin ozone concentration during flight must be shown not to exceed:

(1) 0.25 parts per million by volume, sea level equivalent, at any time above flight level 320; and

(2) 0.1 parts per million by volume, sea level equivalent, time-weighted average during any 3-hour interval above flight level 270.

(b) For the purpose of this section, "sea level equivalent" refers to conditions of 25°C and 760 millimetres of mercury pressure.

(c) Compliance with this section must be shown by analysis or tests based on aeroplane operational procedures and performance limitation, that demonstrate that either:

(1) The aeroplane cannot be operated at an altitude which would result in cabin ozone concentrations exceeding the limits prescribed by paragraph (a) of this section; or

(2) The aeroplane ventilation system, including any ozone control equipment, will maintain cabin ozone concentrations at or below the limits prescribed by paragraph (a) of this section.

525.833 *Combustion Heating Systems*

Combustion heaters must be approved.

(Change 525-3 (91-11-01))

Pressurisation

525.841 *Pressurised Cabins*

(a) Pressurised cabins and compartments to be occupied must be equipped to provide a cabin pressure altitude of not more than 8,000 feet at the maximum operating altitude of the aeroplane under normal operating conditions.

(1) If certification for operation above 25,000 feet is requested, the aeroplane must be designed so that occupants will not be exposed to cabin pressure altitudes in excess of 15,000 feet after any probable failure condition in the pressurisation system.

(2) The aeroplane must be designed so that occupants will not be exposed to a cabin pressure altitude that exceeds the following after decompression from any failure condition not shown to be extremely improbable:

(i) Twenty-five thousand (25,000) feet for more than 2 minutes; or

(ii) Forty thousand (40,000) feet for any duration.

(3) Fuselage structure, engine and system failures are to be considered in evaluating the cabin decompression.

(b) Pressurised cabins must have at least the following valves, controls, and indicators for controlling cabin pressure:

(1) Two pressure relief valves to automatically limit the positive pressure differential to a predetermined valve at the maximum rate of flow delivered by the pressure source. The combined capacity of the relief valve must be large enough so that the failure of any one valve would not cause an appreciable rise in the pressure differential. The pressure differential is positive when the internal pressure is greater than the external.

(2) Two reverse pressure differential relief valves (or their equivalents) to automatically prevent a negative pressure differential that would damage the structure. One valve is enough, however, if it is of a design that reasonably precludes its malfunctioning.

(3) A means by which the pressure differential can be rapidly equalised.

(4) An automatic or manual regulator for controlling the intake or exhaust airflow, or both, for maintaining the required internal pressures and airflow rates.

(5) Instruments at the pilot or flight engineer station to show the pressure differential, the cabin pressure altitude, and the rate of change of the cabin pressure altitude.

(6) Warning indication at the pilot or flight engineer station to indicate when the safe or pre-set pressure differential and cabin pressure altitude limits are exceeded. Appropriate warning markings on the cabin pressure differential indicator meet the warning requirement for pressure differential limits and an aural or visual signal (in addition to cabin altitude indicating means) meets the warning requirement for cabin pressure altitude limits if it warns the flight crew when the cabin pressure altitude exceeds 10,000 feet.

(7) A warning placard at the pilot or flight engineer station if the structure is not designed for pressure differentials up to the maximum relief valve setting in combination with landing loads.

(8) The pressure sensors necessary to meet the requirements of paragraphs (b)(5) and (b)(6) of this section and 525.1447(c), must be located and the sensing system designed so that, in the event of loss of cabin pressure in any passenger or crew compartment (including upper and lower lobe galleys), the warning and automatic presentation devices, required by those provisions, will be actuated without any delay that would significantly increase the hazards resulting from decompression.

(Change 525-8)

525.843 *Tests for Pressurised Cabins*

(a) Strength Test. The complete pressurised cabin, including doors, windows, and valves, must be tested as a pressure vessel for the pressure differential specified in 525.365*(d)*.

(b) Functional Tests. The following functional tests must be performed:

(1) Tests of the functioning and capacity of the positive and negative pressure differential valves, and of the emergency release valve, to simulate the effects of closed regulator valves.

(2) Tests of the pressurisation system to show proper functioning under each possible condition of pressure, temperature, and moisture, up to the maximum altitude for which certification is requested.

(3) Flight tests, to show the performance of the pressure supply, pressure and flow regulators, indicators, and warning signals, in steady and stepped climbs and descents at rates corresponding to the maximum attainable within the operating limitations of the aeroplane, up to the maximum altitude for which certification is requested.

(4) Tests of each door and emergency exit, to show that they operate properly after being subjected to the flight tests prescribed in subparagraph (3) of this paragraph.

Fire Protection

525.851 *Fire Extinguishers*

(a) Hand fire extinguishers.

(1) The following minimum number of hand fire extinguishers must be conveniently located and evenly distributed in passenger compartments:

Passenger Capacity:	No. Of Extinguishers
7 through 30	1
31 through 60	2
61 through 200	3
201 through 300	4
301 through 400	5
401 through 500	6
501 through 600	7
601 through 700	8

(2) At least one hand fire extinguisher must be conveniently located in the pilot compartment.

(3) At least one readily accessible hand fire extinguisher must be available for use in each Class A or Class B cargo or baggage compartment and in each Class E cargo or baggage compartment that is accessible to crew members in flight.

(4) At least one hand fire extinguisher must be located in, or readily accessible for use in, each galley located above or below the passenger compartment.

(5) Each hand fire extinguisher must be approved.

(6) At least one of the required fire extinguishers located in the passenger compartment of an aeroplane with a passenger capacity of at least 31 and not more than 60, and at least two of the fire extinguishers located in the passenger compartment of an aeroplane with a passenger capacity of 61 or more must contain Halon 1211 (bromochlorodifluoromethane $CBrC_1F_2$, or equivalent, as the extinguishing agent. The type of extinguishing agent used in any other extinguisher required by this section must be appropriate for the kinds of fires likely to occur where used.

(7) The quantity of extinguishing agent used in each extinguisher required by this section must be appropriate for the kinds of fires likely to occur where used.

(8) Each extinguisher intended for use in a personnel compartment must be designed to minimise the hazard of toxic gas concentration.

(b) Built-in Fire Extinguishers. If a built-in fire extinguisher is provided:

(1) Each built-in fire extinguishing system must be installed so that:

(i) No extinguishing agent likely to enter personnel compartments will be hazardous to the occupants; and

(ii) No discharge of the extinguisher can cause structural damage.

(2) The capacity of each required built-in fire extinguishing system must be adequate for any fire likely to occur in that compartment where used, considering the volume of the compartment and the ventilation rate.

(Change 525-3 (91-11-01))

525.853 *Compartment Interiors*

For each compartment occupied by the crew or passengers, the following apply:

(a) Materials (including finishes or decorative surfaces applied to the materials) must meet the applicable test criteria prescribed in Part I of Appendix F of this chapter or other approved equivalent methods.

(b) (Reserved)

(c) In addition to meeting the requirements of paragraph *(a)* of this section, seat cushions, except those on flight crew member seats, must meet the test requirements of Part II of Appendix F of this chapter, or other equivalent methods, regardless of the passenger capacity of the aeroplane.

(d) Except as provided in paragraph *(e)* of this section, the following interior components of aeroplanes with passenger capacities of 20 or more must also meet the test requirements of Parts IV and V of Appendix F of this chapter, or other approved equivalent methods, in addition to the flammability requirements prescribed in paragraph *(a)* of this section:

(1) Interior ceiling and wall panels, other than lighting lenses and windows;

(2) Partitions, other than transparent panels needed to enhance cabin safety;

(3) Galley structure, including exposed surfaces of stowed carts and standard containers and the cavity walls that are exposed when a full complement of such carts or containers is not carried;

(4) Large cabinets and cabin stowage compartments, other than underseat stowage compartments for stowing small items such as magazines and maps.

(e) The interiors of compartments, such as pilot compartments, galleys, lavatories, crew rest quarters, cabinets and stowage compartments, need not meet the standards of paragraph *(d)* of this section, provided the interiors of such compartments are isolated from the main passenger cabin by doors or equivalent means that would normally be closed during an emergency landing condition.

(f) Smoking is not to be allowed in lavatories. If smoking is allowed in any area occupied by the crew or passengers, an adequate number of self-contained, removable ashtrays shall be provided in designated smoking sections for all seated occupants.
(amended 2007/03/08)

(g) Regardless of whether smoking is allowed in any other part of the aeroplane, lavatories must have self-contained, removable ashtrays located conspicuously on or near the entry side of each lavatory door, except that one ashtray may serve more than one lavatory door if the ashtray can be seen readily from the cabin side of each lavatory served.

(h) Each receptacle used for the disposal of flammable waste material must be fully enclosed, constructed of at least fire resistant materials, and must contain fires likely to occur in it under normal use. The capability of the receptacle to contain those fires under all probable conditions of wear, misalignment, and ventilation expected in service must be demonstrated by test.

(Change 525-1 (87-01-01))
(Change 525-3 (91-11-01))
(Change 525-6 (93-12-30))
(Change 525-7 (96-09-30))

525.854 *Lavatory Fire Protection*

For aeroplanes with a passenger capacity of 20 or more:

(a) Each lavatory must be equipped with a smoke detector system or equivalent that provides a warning light in the cockpit, or provides a warning light or audible warning in the passenger cabin that would be readily detected by a flight attendant; and

(b) Each lavatory must be equipped with a built-in fire extinguisher for each disposal receptacle for towels, paper, or waste, located within the lavatory. The extinguisher must be designed to discharge automatically into each disposal receptacle upon occurrence of a fire in that receptacle.

(Change 525-3 (91-11-01))

525.855 *Cargo and Baggage Compartments*

For each cargo and baggage compartment, the following apply:
(amended 2007/03/08)

(a) The compartment must meet one of the class requirements of 525.857.

(b) Class B through Class E cargo or baggage compartments, as defined in 525.857, must have a liner and the liner must be separate from (but may be attached to) the aeroplane structure.

(c) Ceiling and sidewall liner panels of Class C compartments must meet the test requirements of Part III of Appendix F of this chapter or other approved equivalent methods.

(d) All other materials used in the construction of the cargo or baggage compartment must meet the applicable test criteria prescribed in Part I of Appendix F of this chapter or other approved equivalent methods.

(e) No compartment must contain any controls, lines, equipment, or accessories whose damage or failure would affect safe operation, unless those items are protected so that:
(amended 2009/05/11)

(1) They cannot be damaged by the movement of cargo in the compartment; and

(2) Their breakage or failure will not create a fire hazard.

(f) There must be means to prevent cargo or baggage from interfering with the functioning of the fire-protective features of the compartment.

(g) Sources of heat within the compartment must be shielded and insulated to prevent igniting the cargo or baggage.

(h) Flight tests must be conducted to show compliance with the provisions of 525.857 concerning:

(1) Compartment accessibility;

(2) The entries of hazardous quantities of smoke or extinguishing agent into compartments occupied by the crew or passengers; and

(3) The dissipation of the extinguishing agent in Class C compartments.

(i) During the above tests, it must be shown that no inadvertent operation of smoke or fire detectors in any compartment would occur as a result of fire contained in any other compartment, either during or after extinguishment, unless the extinguishing system floods each such compartment simultaneously.

(j) Cargo or baggage compartment electrical wiring interconnection system components must meet the requirements of 525.1721.
(amended 2009/05/11)

(Change 525-1 (87-01-01))
(Change 525-3 (91-11-01))
(Change 525-8)

525.856 *Thermal/Acoustic Insulation Materials*
(amended 2004/06/08)

(a) Thermal/acoustic insulation material installed in the fuselage shall meet the flame propagation test requirements of part VI of Appendix F to this chapter, or other approved equivalent test requirements. This requirement does not apply to "small parts," as defined in part I of Appendix F of this chapter.
(amended 2004/06/08)

(b) For aeroplanes with a passenger capacity of 20 or greater, thermal/acoustic insulation materials (including the means of fastening the materials to the fuselage) installed in the lower half of the aeroplane fuselage shall meet the flame penetration resistance test requirements of part VII of Appendix F to this chapter, or other approved equivalent test requirements. This requirement does not apply to thermal/acoustic insulation installations that Transport Canada Civil Aviation finds would not contribute to fire penetration resistance.
(amended 2004/06/08)

525.857 *Cargo Compartment Classification*

(a) Class A. Class A cargo or luggage compartment is one in which:

(1) The presence of a fire would be easily discovered by a crew member while at his station; and

(2) Each part of the compartment is easily accessible in flight.

(b) Class B. A Class B cargo or baggage compartment is one in which:

(1) There is sufficient access in flight to enable a crew member to effectively reach any part of the compartment with the contents of a hand fire extinguisher;

(2) When the access provisions are being used, no hazardous quantity of smoke, flames, or extinguishing agent, will enter any compartment occupied by the crew or passengers;

(3) There is a separate approved smoke detector or fire detector system to give warning at the pilot or flight engineer station; and

(4) (Reserved)

(c) Class C. A Class C cargo or baggage compartment is one not meeting the requirements for either a Class A or B compartment but in which:

(1) There is a separate approved smoke detector or fire detector system to give warning at the pilot or flight engineer station;

(2) There is an approved built-in fire extinguishing or suppression system controllable from the cockpit;

(3) There are means to exclude hazardous quantities of smoke, flames, or extinguishing agent, from any compartment occupied by the crew or passengers;

(4) There are means to control ventilation and drafts within the compartment so that the extinguishing agent used can control any fire that may start within the compartment; and

(5) (Reserved)

(d) Removed and Reserved

(e) Class E. A Class E cargo compartment is one on aeroplanes used only for the carriage of cargo and in which:

(1) (Reserved)

(2) There is a separate approved smoke or fire detector system to give warning at the pilot or flight engineer station;

(3) There are means to shut off the ventilating airflow to, or within, the compartment, and the controls for these means are accessible to the flight crew in the crew compartment;

(4) There are means to exclude hazardous quantities of smoke, flames, or noxious gases, from the flight crew compartment; and

(5) The required crew emergency exits are accessible under any cargo loading condition.

(Change 525-1 (87-01-01))
(Change 525-8)

525.858 *Cargo or Baggage Compartment Smoke or Fire Detection Systems*

If certification with cargo or baggage compartment smoke or fire detection provisions is requested, the following must be met for each cargo or baggage compartment with those provisions:

(a) The detection system must provide a visual indication to the flight crew within one minute after the start of a fire.

(b) The system must be capable of detecting a fire at a temperature significantly below that at which the structural integrity of the aeroplane is substantially decreased.

(c) There must be means to allow the crew to check in flight, the functioning of each fire detector circuit.

(d) The effectiveness of the detection system must be shown for all approved operating configurations and conditions.

(Change 525-8)

525.859 *Combustion Heater Fire Protection*

(a) Combustion heater fire zones. The following combustion heater fire zones must be protected from fire in accordance with the applicable provisions of 525.1181 through 525.1191 and 525.1195 through 525.1203:

(1) The region surrounding the heater, if this region contains any flammable fluid system components (excluding the heater fuel system), that could:

(i) Be damaged by heater malfunctioning; or

(ii) Allow flammable fluids or vapours to reach the heater in case of leakage.

(2) The region surrounding the heater, if the heater fuel system has fittings that, if they leaked, would allow fuel or vapours to enter this region.

(3) The part of the ventilating air passage that surrounds the combustion chamber. However, no fire extinguishment is required in cabin ventilating air passages.

(b) Ventilating air ducts. Each ventilating air duct passing through any fire zone must be fireproof. In addition:

(1) Unless isolation is provided by fireproof valves or by equally effective means, the ventilating air duct downstream of each heater must be fireproof for a distance great enough to ensure that any fire originating in the heater can be contained in the duct; and

(2) Each part of any ventilating duct passing through any region having a flammable fluid system must be constructed or isolated from that system so that the malfunctioning of any component of that system cannot introduce flammable fluids or vapours into the ventilating airstream.

(c) Combustion air ducts. Each combustion air duct must be fireproof for a distance great enough to prevent damage from backfiring or reverse flame propagation. In addition:

(1) No combustion air duct may have a common opening with the ventilating airstream unless flames from backfires or reverse burning cannot enter the ventilating airstream under any operating condition, including reverse flow or malfunctioning of the heater or its associated components; and

(2) No combustion air duct may restrict the prompt relief of any backfire that, if so restricted, could cause heater failure.

(d) Heater controls; general. Provision must be made to prevent the hazardous accumulation of water or ice on or in any heater control component, control system tubing, or safety control.

(e) Heater safety controls. For each combustion heater there must be the following safety control means:

(1) Means independent of the components provided for the normal continuous control of air temperature, airflow, and fuel flow must be provided, for each heater, to automatically shut off the ignition and fuel supply to that heater at a point remote from that heater when any of the following occurs:

(i) The heat exchanger temperature exceeds safe limits.

(ii) The ventilating air temperature exceeds safe limits.

(iii) The combustion airflow becomes inadequate for safe operation.

(iv) The ventilating airflow becomes inadequate for safe operation.

(2) The means of complying with subparagraph (1) of this paragraph for any individual heater must:

(i) Be independent of components serving any other heater whose heat output is essential for safe operation; and

(ii) Keep the heater off until restarted by the crew.

(3) There must be means to warn the crew when any heater whose heat out-put is essential for safe operation has been shut off by the automatic means prescribed in subparagraph (1) of this paragraph.

(f) Air intakes. Each combustion and ventilating air intake must be located so that no flammable fluids or vapours can enter the heater system under any operating condition:

(1) During normal operation; or

(2) As a result of the malfunctioning of any other component.

(g) Heater exhaust. Heater exhaust systems must meet the provisions of 525.1121 and 525.1123. In addition, there must be provisions in the design of the heater exhaust system to safely expel the products of combustion to prevent the occurrence of:

(1) Fuel leakage from the exhaust to surrounding compartments;

(2) Exhaust gas impingement on surrounding equipment or structure;

(3) Ignition of flammable fluids by the exhaust, if the exhaust is in a compartment containing flammable fluid lines; and

(4) Restriction by the exhaust of the prompt relief of backfires that, if so restricted, could cause heater failure.

(h) Heater fuel systems. Each heater fuel system must meet each powerplant fuel system requirement affecting safe heater operation. Each heater fuel system component within the ventilating airstream must be protected by shrouds so that no leakage from those components can enter the ventilating airstream.

(i) *Drains*. There must be means to safely drain fuel that might accumulate within the combustion chamber or the heat exchanger. In addition:

(1) Each part of any drain that operates at high temperatures must be protected in the same manner as heater exhausts; and

(2) Each drain must be protected from hazardous ice accumulation under any operating condition.

525.863 *Flammable Fluid Fire Protection*

(a) In each area where flammable fluids or vapours might escape by leakage of a fluid system, there must be means to minimise the probability of ignition of the fluids and vapours, and the resultant hazards if ignition does occur.

(b) Compliance with paragraph *(a)* of this section must be shown by analysis or tests, and the following factors must be considered.

(1) Possible sources and paths of fluid leakage, and means of detecting leakage.

(2) Flammability characteristics of fluids, including effects of any combustible or absorbing materials.

(3) Possible ignition sources, including electrical faults, overheating of equipment, and malfunctioning of protective devices.

(4) Means available for controlling or extinguishing a fire, such as stopping flow of fluids, shutting down equipment, fireproof containment, or use of extinguishing agents.

(5) Ability of aeroplane components that are critical to safety of flight to withstand fire and heat.

(c) If action by the flight crew is required to prevent or counteract a fluid fire (e.g. equipment shutdown or actuation of a fire extinguisher) quick acting means must be provided to alert the crew.

(d) Each area where flammable fluids or vapours might escape by leakage of a fluid system must be identified and defined.

525.865 *Fire Protection of Flight Controls, Engine Mounts, and Other Flight Structure*

Essential flight controls, engine mounts, and other flight structures located in designated fire zones or in adjacent areas which would be subjected to the effects of fire in the fire zone must be constructed of fireproof material or shielded so that they are capable of withstanding the effects of fire.

525.867 *Fire Protection: Other Components*

(a) Surfaces to the rear of the nacelles, within one nacelle diameter of the nacelle centreline, must be at least fire-resistant.

(b) Paragraph *(a)* of this section does not apply to tail surfaces to the rear of the nacelles that could not be readily affected by heat, flames or sparks coming from a designated fire zone or engine compartment of any nacelle.

525.869 *Fire Protection: Systems*

(a) Electrical system components:

(1) Components of the electrical system must meet the applicable fire and smoke protection requirements of 525.831(c) and 525.863.

(2) Equipment that is located in designated fire zones and is used during emergency procedures must be at least fire-resistant.
(amended 2009/05/11)

(3) EWIS components must meet the requirements of 525.1713.
(amended 2009/05/11)

(b) Each vacuum air system line and fitting on the discharge side of the pump that might contain flammable vapours or fluids must meet the requirements of 525.1183 if the line or fitting is in a designated fire zone. Other vacuum air systems components in designated fire zones must be at least fire resistant.

(c) Oxygen equipment and lines must:

(1) Not be located in any designated fire zone,

(2) Be protected from heat that may be generated in, or escape from, any designated fire zone, and

(3) Be installed so that escaping oxygen cannot cause ignition of grease, fluid, or vapour accumulations that are present in normal operation or as a result of failure of malfunction of any system.

(Change 525-3 (91-11-01))

Miscellaneous

525.871 *Levelling Means*

There must be means for determining when the aeroplane is in a level position on the ground.

525.875 *Reinforcement Near Propellers*

(a) Each part of the aeroplane near the propeller tips must be strong and stiff enough to withstand the effects of the induced vibration and of ice thrown from the propeller.

(b) No window may be near the propeller tips unless it can withstand the most severe ice impact likely to occur.

525.899 *Electrical Bonding and Protection Against Static Electricity*
(amended 2009/05/11)

(a) Electrical bonding and protection against static electricity must be designed to minimize accumulation of electrostatic charge that would cause:
(amended 2009/05/11)

(1) Human injury from electrical shock,
(amended 2009/05/11)

(2) Ignition of flammable vapors, or
(amended 2009/05/11)

(3) Interference with installed electrical/electronic equipment.
(amended 2009/05/11)

(b) Compliance with paragraph (a) of this section may be shown by:
(amended 2009/05/11)

(1) Bonding the components properly to the airframe; or
(amended 2009/05/11)

(2) Incorporating other acceptable means to dissipate the static charge so as not to endanger the aeroplane, personnel, or operation of the installed electrical/electronic systems.
(amended 2009/05/11)

SUBCHAPTER E

Powerplant: General

525.901 *Installation*

(a) For the purpose of this chapter, the aeroplane powerplant installation includes each component that:

(1) Is necessary for propulsion;

(2) Affects the control of the major propulsive units; or

(3) Affects the safety of the major propulsive units between normal inspections or overhauls.

(b) For each powerplant:

(1) The installation must comply with:

(i) The installation instructions provided under 533.5 and 535.3 of this Manual; and
(amended 2010/01/29)

(ii) The applicable provisions of this subchapter;

(2) The components of the installation must be constructed, arranged, and installed so as to ensure their continued safe operation between normal inspections or overhauls;

(3) The installation must be accessible for necessary inspections and maintenance; and

(4) The major components of the installation must be electrically bonded to the other parts of the aeroplane.

(c) For each powerplant and auxiliary power unit installation, it must be established that no single failure or malfunction or probable combination of failures will jeopardise the safe operation of the aeroplane except that the failure of structural elements need not be considered if the probability of such failure is extremely remote.

(d) Each auxiliary power unit installation must meet the applicable provisions of this subchapter.

525.903 *Engines*

(a) <u>*Engine Type Certificate*</u>.

<u>(1) Each engine must have a type certificate and must meet the applicable requirements of </u>Chapter 516, Second Edition, subchapter B<u> of this manual.</u>

FAR:

(1) Each engine must have a type certificate and must meet the applicable requirements of Part 34 of this chapter.

(2) Each turbine engine shall comply with one of the following:
(amended 2003/12/11)

(i) Sections 533.76, 533.77 and 533.78 of chapter 533 in effect on 5 March 2001, or as subsequently amended; or
(amended 2003/12/11)

(ii) Sections 533.77 and 533.78 of chapter 533 in effect on 29 October 1998, or as subsequently amended before 5 March 2001; or
(amended 2003/12/11)

(iii) Either of:
(amended 2003/12/11)

(A) FAR 33.77 in effect on October 31, 1974, or as subsequently amended prior to 1 January 1986, unless that engine's foreign object ingestion service history has resulted in an unsafe condition; or
(amended 2003/12/11)

(B) After 1 January 1986, section 533.77 of chapter 533, or as subsequently amended prior to 29 October 1998, unless that engine's foreign object ingestion service history has resulted in an unsafe condition; or
(amended 2003/12/11)

FAR:

(iii) Comply with FAR 33.77 of this chapter in effect on October 31, 1974, or as subsequently amended prior to April 30, 1998, unless that engine's foreign object ingestion service history has resulted in an unsafe condition; or
(amended 2003/12/11)

(iv) Be shown to have a foreign object ingestion service history in similar installation locations which has not resulted in any unsafe condition.
(amended 2003/12/11)

(b) Engine isolation. The powerplants must be arranged and isolated from each other to allow operation, in at least one configuration, so that the failure or malfunction of any engine, or of any system that can affect the engine, will not:

(1) Prevent the continued safe operation of the remaining engines; or

(2) Require immediate action by any crew member for continued safe operation.

(c) Control of engine rotation. There must be means for stopping the rotation of any engine individually in flight, except that, for turbine engine installations, the means for stopping the rotation of any engine need be provided only where continued rotation could jeopardise the safety of the aeroplane. Each component of the stopping system on the engine side of the firewall that might be exposed to fire must be at least fire-resistant. If hydraulic propeller

feathering systems are used for this purpose, the feathering lines must be at least fire-resistant under the operating conditions that may be expected to exist during feathering.

(d) Turbine engine installations. For turbine engine installations:

(1) Design precautions must be taken to minimise the hazards to the aeroplane in the event of an engine rotor failure or of a fire originating within the engine which burns through the engine case.

(2) The powerplant systems associated with engine control devices, systems, and instrumentation, must be designed to give reasonable assurance that those engine operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

(e) Restart capability.

(1) Means to restart any engine in flight must be provided.

(2) An altitude and airspeed envelope must be established for in-flight engine restarting, and each engine must have a restart capability within that envelope.

(3) For turbine engine powered aeroplanes, if the minimum windmilling speed of the engines, following the in-flight shutdown of all engines, is insufficient to provide the necessary electrical power for engine ignition, a power source independent of the engine-driven electrical power generating system must be provided to permit in-flight engine ignition for restarting.

(f) Auxiliary Power Unit. Each auxiliary power unit must be approved or meet the requirements of the category for its intended use.

(Change 525-3 (91-11-01))
(Change 525-4 (92-08-01))
(Change 525-8)

525.904 *Automatic Take-off Thrust Control System (ATTCS)*

Each applicant seeking approval for installation of an engine power control system that automatically resets the power or thrust on the operating engine(s) when any engine fails during the take-off must comply with the requirements of Appendix I of this chapter.

(Change 525-2 (89-01-01))

525.905 *Propellers*

(a) Each propeller must have a type certificate.

(b) Engine power and propeller shaft rotational speed may not exceed the limits for which the propeller is certificated.

(c) The propeller blade pitch control system must meet the requirements of 535.21, 535.23, 535.42 and 535.43 of this Manual.
(amended 2010/01/29)

(d) Design precautions must be taken to minimise the hazards to the aeroplane in the event a propeller blade fails or is released by a hub failure. The hazards which must be considered

include damage to structure and vital systems due to impact of a failed or released blade and the unbalance created by such failure or release.

(Change525-3 (91-11-01))

525.907 *Propeller Vibration and Fatigue*
(amended 2010/01/29)

This section does not apply to fixed-pitch wood propellers of conventional design. (amended 2010/01/29)

(a) The applicant must determine the magnitude of the propeller vibration stresses or loads, including any stress peaks and resonant conditions, throughout the oeprational envelope of the aeroplane by either:
(amended 2010/01/29)

(1) Measurement of stresses or loads through direct testing or analysis based on direct testing of the propeller on the aeroplane and engine installation for which approval is sought; or
(amended 2010/01/29)

(2) Comparison of the propeller to similar propellers installed on similar aeroplane installations for which these measurements have been made.
(amended 2010/01/29)

(b) The applicant must demonstrate by tests, analysis based on tests, or previous experience on similar designs that the propeller does not experience harmful effects of flutter throughout the operational envelope of the aeroplane.
(amended 2010/01/29)

(c) The applicant must perform an evaluation of the propeller to show that failure due to fatigue will be avoided throughout the operational life of the propeller using the fatigue and structural data obtained in accordance with *Airworthiness Manual* Chapter 535 and the vibration data obtained from compliance with paragraph (a) of this section. For the purpose of this paragraph, the propeller includes the hub, blades, blade retention component and any other propeller component whose failure due to fatigue could be catastrophic to the aeroplane. This evaluation must include:
(amended 2010/01/29)

(1) The intended loading spectra including all reasonably foreseeable propeller vibration and cyclic load patterns, identified emergency conditions, allowable overspeeds and overtorques and the effects of temperatures and humidity expected in service.
(amended 2010/01/29)

(2) The effects of aeroplane and propeller operating and airworthiness limitations.
(amended 2010/01/29)

525.925 *Propeller Clearance*

Unless smaller clearances are substantiated, propeller clearances with the aeroplane at maximum weight, with the most adverse centre of gravity, and with the propeller in the most adverse pitch position, may not be less than the following:

(a) Ground clearance. There must be a clearance of at least seven inches (for each aeroplane with nose wheel landing gear) or nine inches (for each aeroplane with tail wheel landing gear) between each propeller and the ground with the landing gear statically deflected and in the level take-off, or taxiing attitude, whichever is most critical. In addition, there must be positive clearance between the propeller and the ground when in the level take-off attitude with the critical tire(s) completely deflated and the corresponding landing gear strut bottomed.

(b) Water clearance. There must be a clearance of at least 18 inches between each propeller and the water, unless compliance with 525.239*(a)* can be shown with a lesser clearance.

(c) Structural clearance. There must be:

(1) At least one inch radial clearance between the blade tips and the aeroplane structure, plus any additional radial clearance necessary to prevent harmful vibration;

(2) At least one-half inch longitudinal clearance between the propeller blades or cuffs and stationary parts of the aeroplane; and

(3) Positive clearance between other rotating parts of the propeller or spinner and stationary parts of the aeroplane.

(Change 525-3 (91-11-01))

525.929 *Propeller De-icing*

(a) For aeroplanes intended for use where icing may be expected, there must be a means to prevent or remove hazardous ice accumulation on propellers or on accessories where ice accumulation would jeopardise engine performance.

(b) If combustible fluid is used for propeller de-icing, 525.1181 through 525.1185 and 525.1189 apply.

525.933 *Reversing Systems*

(a) For turbojet reversing systems:

(1) Each system intended for ground operation only must be designed so that during any reversal in flight the engine will produce no more than flight idle thrust. In addition, it must be shown by analysis or test, or both, that:

(i) Each operable reverser can be restored to the forward thrust position; and

(ii) The aeroplane is capable of continued safe flight and landing under any possible position of the thrust reverser.

(2) Each system intended for in-flight use must be designed so that no unsafe condition will result during normal operation of the system, or from any failure (or reasonably likely combination of failures) of the reversing system, under any anticipated condition of

operation of the aeroplane including ground operation. Failure of structural elements need not be considered if the probability of this kind of failure is extremely remote.

(3) Each system must have means to prevent the engine from producing more than idle thrust when the reversing system malfunctions, except that it may produce any greater forward thrust that is shown to allow directional control to be maintained, with aerodynamic means alone, under the most critical reversing condition expected in operation.

(b) For propeller reversing systems:

(1) Each system intended for ground operation only must be designed so that no single failure (or reasonably likely combination of failures) or malfunction of the system will result in unwanted reverse thrust under any expected operating condition. Failure of structural elements need not be considered if this kind of failure is extremely remote.

(2) Compliance with this section may be shown by failure analysis or testing, or both, for propeller systems that allow propeller blades to move from the flight low-pitch position to a position that is substantially less than that at the normal flight low-pitch position. The analysis may include or be supported by the analysis made to show compliance with the requirements of 535.21 of this manual for the propeller and associated installation components.

(Change 525-2 (89-01-01))
(Change 525-3 (91-11-01))

525.934 *Turbojet Engine Thrust Reverser System Tests*

Thrust reversers installed on turbo jet engines must meet the requirements of 533.97 of this manual.

525.937 *Turbopropeller-drag Limiting Systems*

Turbopropeller powered aeroplane propeller-drag limiting systems must be designed so that no single failure or malfunction of any of the systems during normal or emergency operation results in propeller drag in excess of that for which the aeroplane was designed under 525.367. Failure of structural elements of the drag limiting systems need not be considered if the probability of this kind of failure is extremely remote.

525.939 *Turbine Engine Operating Characteristics*

(a) Turbine engine operating characteristics must be investigated in flight to determine that no adverse characteristics (such as stall, surge, or flameout) are present, to a hazardous degree, during normal and emergency operation within the range of operating limitations of the aeroplane and of the engine.

(b) (Reserved)

(c) The turbine engine air inlet system may not, as a result of air flow distortion during normal operation, cause vibration harmful to the engine.

525.941 *Inlet, Engine, and Exhaust Compatibility*

For aeroplanes using variable inlet or exhaust system geometry, or both:

(a) The system comprised of the inlet, engine (including thrust augmentation systems, if incorporated), and exhaust must be shown to function properly under all operating conditions for which approval is sought, including all engine rotating speeds and power settings, and engine inlet and exhaust configurations;

(b) The dynamic effects of the operation of these (including consideration of probable malfunctions) upon the aerodynamic control of the aeroplane may not result in any condition that would require exceptional skill, alertness, or strength on the part of the pilot to avoid exceeding an operational or structural limitation of the aeroplane; and

(c) In showing compliance with paragraph *(b)* of this section, the pilot strength required shall not exceed the limits set forth in 525.143*(d)*, subject to the conditions set forth in paragraphs *(e)* and *(f)* of 525.143.
(amended 2008/10/30)

525.943 *Negative Acceleration*

No hazardous malfunction of an engine, an auxiliary power unit approved for use in flight, or any component or system associated with the powerplant or auxiliary power unit may occur when the aeroplane is operated at the negative accelerations within the flight envelopes prescribed in 525.333. This must be shown for the greatest duration expected for the acceleration.

525.945 *Thrust or Power Augmentation System*

(a) General. Each fluid injection system shall provide a flow of fluid at the rate and pressure established for proper engine functioning under each intended operating condition. If the fluid can freeze, fluid freezing shall not damage the aeroplane or adversely affect aeroplane performance.
(amended 2005/06/03)

(b) Fluid tanks. Each augmentation system fluid tank shall meet the following requirements:
(amended 2005/06/03)

(1) Each tank shall be able to withstand without failure the vibration, inertia, fluid, and structural loads that it may be subjected to in operation.
(amended 2005/06/03)

(2) The tanks as mounted in the aeroplane shall be able to withstand without failure or leakage an internal pressure 1.5 times the maximum operating pressure.
(amended 2005/06/03)

(3) If a vent is provided, the venting shall be effective under all normal flight conditions.
(amended 2005/06/03)

(4) (Reserved)

(5) Each tank shall have an expansion space of not less than 2 percent of the tank capacity. It shall be impossible to fill the expansion space inadvertently with the aeroplane in the normal ground attitude.
(amended 2005/06/03)

(c) Augmentation system drains shall be designed and located in accordance with 525.1455 if:
(amended 2005/06/03)

(1) The augmentation system fluid is subject to freezing; and

(2) The fluid may be drained in flight or during ground operation.

(d) The augmentation liquid tank capacity available for the use of each engine shall be large enough to allow operation of the aeroplane under the approved procedures for the use of liquid-augmented power. The computation of liquid consumption shall be based on the maximum approved rate appropriate for the desired engine output and shall include the effect of temperature on engine performance as well as any other factors that might vary the amount of liquid required.
(amended 2005/06/03)

(e) This section does not apply to fuel injection systems.

(Change 525-3 (91-11-01))

Fuel System

525.951 ***General***

(a) Each fuel system must be constructed and arranged to ensure a flow of fuel at a rate and pressure established for proper engine and auxiliary power unit functioning under each likely operating condition, including any manoeuvre for which certification is requested and during which the engine or auxiliary power unit is permitted to be in operation.

(b) Each fuel system must be arranged so that any air which is introduced into the system will not result in:

(1) Power interruption for more than 20 seconds for reciprocating engines; or

(2) Flame-out for turbine engines.

(c) Each fuel system for a turbine engine must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 80°F and having 0.75cc of free water per gallon added and cooled to the most critical condition for icing likely to be encountered in operation.

(d) Each fuel system for a turbine engine powered aeroplane must meet the applicable fuel venting requirements of Chapter 516, Second Edition, subchapter B of this manual.

(Change 525-3 (91-11-01))

525.952 ***Fuel System Analysis and Test***

(a) Proper fuel system functioning under all probable operating conditions must be shown by analysis and those tests found necessary by the Minister. Tests, if required, must be made using the aeroplane fuel system or a test article that reproduces the operating characteristics of the portion of the fuel system to be tested.

(b) The likely failure of any heat exchanger using fuel as one of its fluids may not result in a hazardous condition.

525.953 *Fuel System Independence*

Each fuel system must meet the requirements of 525.903(b) by:

(a) Allowing the supply of fuel to each engine through a system independent of each part of the system supplying fuel to any other engine; or

(b) Any other acceptable method.

525.954 *Fuel System Lightning Protection*

The fuel system must be designed and arranged to prevent the ignition of fuel vapour within the system by:

(a) Direct lightning strikes to areas having a high probability of stroke attachment;

(b) Swept lightning strokes to areas where swept strokes are highly probable; and

(c) Corona and streamering at fuel vent outlets.

525.955 *Fuel Flow*

(a) Each fuel system must provide at least 100 percent of the fuel flow required under each intended operating condition and manoeuvre. Compliance must be shown as follows:

(1) Fuel must be delivered to each engine at a pressure within the limits specified in the engine type certificate.

(2) The quantity of fuel in the tank may not exceed the amount established as the unusable fuel supply for that tank under the requirements of 525.959 plus that necessary to show compliance with this section.

(3) Each main pump must be used that is necessary for each operating condition and attitude for which compliance with this section is shown, and the appropriate emergency pump must be substituted for each main pump so used.

(4) If there is a fuel flowmeter, it must be blocked and the fuel must flow through the meter or its bypass.

(b) If an engine can be supplied with fuel from more than one tank, the fuel system must:

(1) For each reciprocating engine, supply the full fuel pressure to that engine in not more than 20 seconds after switching to any other fuel tank containing usable fuel when engine malfunctioning becomes apparent due to the depletion of the fuel supply in any tank from which the engine can be fed; and

(2) For each turbine engine, in addition to having appropriate manual switching capability, be designed to prevent interruption of fuel flow to that engine, without attention by the flight crew, when any tank supplying fuel to that engine is depleted of usable fuel during normal operation, and any other tank, that normally supplies fuel to that engine alone, contains usable fuel.

525.957 *Flow Between Interconnected Tanks*

If fuel can be pumped from one tank to another in flight, the fuel tank vents and the fuel transfer system must be designed so that no structural damage to the tanks can occur because of overfilling.

525.959 *Unusable Fuel Supply*

The unusable fuel quantity for each fuel tank and its fuel system components must be established at not less than the quantity at which the first evidence of engine malfunction occurs under the most adverse fuel feed condition for all intended operations and flight manoeuvres involving fuel feeding from that tank. Fuel system component failures need not be considered.

525.961 *Fuel System Hot Weather Operation*

(a) The fuel system must perform satisfactorily in hot weather operation. This must be shown by showing that the fuel system from the tank outlets to each engine is pressurised, under all intended operations, so as to prevent vapour formation, or must be shown by climbing from the altitude of the airport elected by the applicant to the maximum altitude established as an operating limitation under 525.1527. If a climb test is elected, there may be no evidence of vapour lock or other malfunctioning during the climb test conducted under the following conditions:

(1) For reciprocating engine powered aeroplanes, the engines must operate at maximum continuous power, except that take-off power must be used for the altitudes from 1,000 feet below the critical altitude through the critical altitude. The time interval during which take-off power is used may not be less than the take-off time limitation.

(2) For turbine engine powered aeroplanes, the engines must operate at take-off power for the time interval selected for showing the take-off flight path, and at maximum continuous power for the rest of the climb.

(3) The weight of the aeroplane must be the weight with full fuel tanks, minimum crew, and the ballast necessary to maintain the centre of gravity within allowable limits.

(4) The climb airspeed may not exceed:

(i) For reciprocating engine powered aeroplanes, the maximum airspeed established for climbing from take-off to the maximum operating altitude with the aeroplane in the following configuration:

(A) Landing gear retracted.

(B) Wing flaps in the most favourable position.

(C) Cowl flaps (or other means of controlling the engine cooling supply) in the position that provides adequate cooling in the hot-day condition.

(D) Engine operating within the maximum continuous power limitations.

(E) Maximum take-off weight; and

(ii) For turbine engine powered aeroplanes, the maximum airspeed established for climbing from take-off to the maximum operating altitude.

(5) The fuel temperature must be at least 110°F.

(b) The test prescribed in paragraph *(a)* of this section may be performed in flight or on the ground under closely simulated flight conditions. If a flight test is performed in weather

cold enough to interfere with the proper conduct of the test, the fuel tank surfaces, fuel lines, and other fuel system parts subject to cold air must be insulated to simulate, insofar as practicable, flight in hot weather.

525.963 *Fuel Tanks: General*

(a) Each fuel tank must be able to withstand, without failure, the vibration, inertia, fluid, and structural loads that it may be subjected to in operation.

(b) Flexible fuel tank liners must be approved or must be shown to be suitable for the particular application.

(c) Integral fuel tanks must have facilities for interior inspection and repair.

(d) Fuel tanks within the fuselage contour must be able to resist rupture, and to retain fuel, under the inertia forces prescribed for the emergency landing conditions in 525.561. In addition, these tanks must be in a protected position so that exposure of the tanks to scraping action with the ground is unlikely.

(e) Fuel tank access covers must comply with the following criteria in order to avoid loss of hazardous quantities of fuel:

(1) All covers located in an area where experience or analysis indicates a strike is likely must be shown by analysis or test to minimise penetration and deformation by tire fragments, low energy engine debris, or other likely debris.

(2) All covers must be fire resistant as defined in Chapter 500 of this manual.

(f) For pressurised fuel tanks, a means with fail-safe features must be provided to prevent the build-up of an excessive pressure difference between the inside and the outside of the tank.

(Change 525-3 (91-11-01))

525.965 *Fuel Tank Tests*

(a) It must be shown by tests that the fuel tanks, as mounted in the aeroplane, can withstand, without failure or leakage, the more critical of the pressures resulting from the conditions specified in subparagraphs (1) and (2) of this paragraph. In addition, it must be shown by either analysis or tests, that tank surfaces subjected to more critical pressures resulting from the condition of subparagraphs (3) and (4) of this paragraph, are able to withstand the following pressures:

(1) An internal pressure of 3.5 p.s.i.

(2) 125 percent of the maximum air pressure developed in the tank from ram effect.

(3) Fluid pressures developed during maximum limit accelerations, and deflections, of the aeroplane with a full tank.

(4) Fluid pressures developed during the most adverse combination of aeroplane roll and fuel load.

(b) Each metallic tank with large unsupported or unstiffened flat surfaces, whose failure or deformation could cause fuel leakage, must be able to withstand the following test, or its equivalent, without leakage or excessive deformation of the tank walls:

(1) Each complete tank assembly and its supports must be vibration tested while mounted to simulate the actual installation.

(2) Except as specified in subparagraph (4) of this paragraph, the tank assembly must be vibrated for 25 hours at an amplitude of not less than 1/32 of an inch (unless another amplitude is substantiated) while 2/3 filled with water or other suitable test fluid.

(3) The test frequency of vibration must be as follows:

(i) If no frequency of vibration resulting from any r.p.m. within the normal operating range of engine speeds is critical, the test frequency of vibration must be 2,000 cycles per minute.

(ii) If only one frequency of vibration resulting from any r.p.m. within the normal operating range of engine speeds is critical, that frequency of vibration must be the test frequency.

(iii) If more than one frequency of vibration resulting from any r.p.m. within the normal operating range of engine speeds is critical, the most critical of these frequencies must be the test frequency.

(4) Under subparagraphs (3)(ii) and (iii) of this paragraph, the time of test must be adjusted to accomplish the same number of vibration cycles that would be accomplished in 25 hours at the frequency specified in subparagraph (3)(i) of this paragraph.

(5) During the test, the tank assembly must be rocked at the rate of 16 to 20 complete cycles per minute, through an angle of 15° on both sides of the horizontal (30° total), about the most critical axis, for 25 hours. If motion about more than one axis is likely to be critical, the tank must be rocked about each critical axis for 12½ hours.

(c) Except where satisfactory operating experience with a similar tank in a similar installation is shown, non-metallic tanks must withstand the test specified in paragraph *(b)*(5) of this section, with fuel at a temperature of 110° F. During this test, a representative specimen of the tank must be installed in a supporting structure simulating the installation in the aeroplane.

(d) For pressurised fuel tanks, it must be shown by analysis or tests that the fuel tanks can withstand the maximum pressure likely to occur on the ground or in flight.

525.967 *Fuel Tank Installations*

(a) Each fuel tank must be supported so that tank loads (resulting from the weight of the fuel in the tanks) are not concentrated on unsupported tank surfaces. In addition:

(1) There must be pads, if necessary, to prevent chafing between the tank and its supports;

(2) Padding must be non-absorbent or treated to prevent the absorption of fluids;

(3) If a flexible tank liner is used, it must be supported so that it is not required to withstand fluid loads; and

(4) Each interior surface of the tank compartment must be smooth and free of projections that could cause wear of the liner unless:

(i) Provisions are made for protection of the liner at these points; or

(ii) The construction of the liner itself provides that protection.

(b) Spaces adjacent to tank surfaces must be ventilated to avoid fume accumulation due to minor leakage. If the tank is in a sealed compartment, ventilation may be limited to drain holes large enough to prevent excessive pressure resulting from altitude changes.

(c) The location of each tank must meet the requirements of 525.1185*(a)*.

(d) No engine nacelle skin immediately behind a major air outlet from the engine compartment may act as the wall of an integral tank.

(e) Each fuel tank must be isolated from personnel compartments by a fumeproof and fuelproof enclosure.

525.969 *Fuel Tank Expansion Space*

Each fuel tank must have an expansion space of not less than 2 percent of the tank capacity. It must be impossible to fill the expansion space inadvertently with the aeroplane in the normal ground attitude. For pressure fuelling systems, compliance with this section may be shown with the means provided to comply with 525.979(b).

525.971 *Fuel Tank Sump*

(a) Each fuel tank must have a sump with an effective capacity, in the normal ground attitude, of not less than the greater of 0.10 percent of the tank capacity or one-sixteenth of a gallon unless operating limitations are established to ensure that the accumulation of water in service will not exceed the sump capacity.

(b) Each fuel tank must allow drainage of any hazardous quantity of water from any part of the tank to its sump with the aeroplane in the ground attitude.

(c) Each fuel tank sump must have an accessible drain that:

(1) Allows complete drainage of the sump on the ground;

(2) Discharges clear of each part of the aeroplane; and

(3) Has manual or automatic means for positive locking in the closed position.

525.973 *Fuel Tank Filler Connection*

Each fuel tank filler connection shall prevent the entrance of fuel into any part of the aeroplane other than the tank itself. In addition:
(amended 2005/06/03)

(a) (Reserved)

(b) Each recessed filler connection that can retain any appreciable quantity of fuel shall have a drain that discharges clear of each part of the aeroplane;
(amended 2005/06/03)

(c) Each filler cap shall provide a fuel-tight seal; and
(amended 2005/06/03)

(d) Each fuel filling point shall have a provision for electrically bonding the aeroplane to ground fuelling equipment.
(amended 2005/06/03)

(Change 525-3 (91-11-01))

525.975 *Fuel Tank Vents and Carburettor Vapour Vents*

(a) Fuel tank vents. Each fuel tank must be vented from the top part of the expansion space so that venting is effective under any normal flight condition. In addition:

(1) Each vent must be arranged to avoid stoppage by dirt or ice formation;

(2) The vent arrangement must prevent siphoning of fuel during normal operation;

(3) The venting capacity and vent pressure levels must maintain acceptable differences of pressure between the interior and exterior of the tank, during:

(i) Normal flight operation;

(ii) Maximum rate of ascent and descent; and

(iii) Refuelling and defuelling (where applicable);

(4) Airspaces of tanks with interconnected outlets must be interconnected;

(5) There may be no point in any vent line where moisture can accumulate with the aeroplane in the ground attitude or the level flight attitude, unless drainage is provided; and

(6) No vent or drainage provision may end at any point:

(i) Where the discharge of fuel from the vent outlet would constitute a fire hazard; or

(ii) From which fumes could enter personnel compartments.

(b) Carburettor vapour vents. Each carburettor with vapour elimination connections must have a vent line to lead vapours back to one of the fuel tanks. In addition:

(1) Each vent system must have means to avoid stoppage by ice; and

(2) If there is more than one fuel tank, and it is necessary to use the tanks in a definite sequence, each vapour vent return line must lead back to the fuel tank used for take-off and landing.

525.977 *Fuel Tank Outlet*

(a) There must be a fuel strainer for the fuel tank outlet or for the booster pump. This strainer must:

(1) For reciprocating engine powered aeroplanes, have 8 to 16 meshes per inch; and

(2) For turbine engine powered aeroplanes, prevent the passage of any object that could restrict fuel flow or damage any fuel system component.

(b) (Reserved)

(c) The clear area of each fuel tank outlet strainer must be at least five times the area of the outlet line.

(d) The diameter of each strainer must be at least that of the fuel tank outlet.

(e) Each finger strainer must be accessible for inspection and cleaning.

525.979 *Pressure Fuelling System*

For pressure fuelling systems, the following apply:

(a) Each pressure fuelling system fuel manifold connection must have means to prevent the escape of hazardous quantities of fuel from the system if the fuel entry valve fails.

(b) An automatic shut-off means must be provided to prevent the quantity of fuel in each tank from exceeding the maximum quantity approved for that tank. This means must:

(1) Allow checking for proper shut-off operation before each fuelling of the tank; and

(2) Provide indication, at each fuelling station, of failure of the shut-off means to stop fuel flow at the maximum quantity approved for that tank.

(c) A means must be provided to prevent damage to the fuel system in the event of failure of the automatic shut-off means prescribed in paragraph *(b)* of this section.

(d) The aeroplane pressure fuelling system (not including fuel tanks and fuel tank vents) must withstand an ultimate load that is 2.0 times the load arising from the maximum pressures, including surge, that is likely to occur during fuelling. The maximum surge pressure must be established with any combination of tank valves being either intentionally or inadvertently closed.

(e) The aeroplane defuelling system (not including fuel tanks and fuel tank vents) must withstand an ultimate load that is 2.0 times the load arising from the maximum permissible defuelling pressure (positive or negative) at the aeroplane fuelling connection.

(Change 525-3 (91-11-01))

525.981 *Fuel Tank Explosion Prevention*
(amended 2009/05/11)

(a) No ignition source may be present at each point in the fuel tank or fuel tank system where catastrophic failure could occur due to ignition of fuel or vapours. This shall be demonstrated by:

(1) Determining the highest temperature allowing a safe margin below the lowest expected auto-ignition temperature of the fuel in the fuel tanks.

(2) Demonstrating that no temperature at each place inside each fuel tank where fuel ignition is possible will exceed the temperature determined under paragraph (a)(1) of this section. This shall be verified under all probable operating, failure, and malfunction conditions of each component whose operation, failure, or malfunction could increase the temperature inside the tank.

(3) Demonstrating that an ignition source could not result from each single failure, from each single failure in combination with each latent failure condition not shown to be extremely remote, and from all combinations of failures not shown to be extremely improbable. The effects of manufacturing variability, aging, wear, corrosion, and likely damage shall be considered.

(b) Except as provided in paragraphs (b)(2) and (c) of this section, no fuel tank Fleet Average Flammability Exposure on an aeroplane may exceed three percent of the Flammability Exposure Evaluation Time (FEET) as defined in Appendix N of this part, or that of a fuel tank within the wing of the aeroplane model being evaluated, whichever is greater. If the wing is not a conventional unheated aluminum wing, the analysis must be based on an assumed Equivalent Conventional Unheated Aluminum Wing Tank.
(amended 2009/05/11)

(1) Fleet Average Flammability Exposure is determined in accordance with Appendix N of this part. The assessment must be done in accordance with the methods and procedures set forth in the Fuel Tank Flammability Assessment Method User's Manual, dated May 2008, document number DOT/FAA/AR–05/8.
(amended 2009/05/11)

(2) Any fuel tank other than a main fuel tank on an aeroplane must meet the flammability exposure criteria of Appendix M to this part if any portion of the tank is located within the fuselage contour.
(amended 2009/05/11)

(3) As used in this paragraph,
(amended 2009/05/11)

(i) Equivalent Conventional Unheated Aluminum Wing Tank is an integral tank in an unheated semi-monocoque aluminum wing of a subsonic aeroplane that is equivalent in aerodynamic performance, structural capability, fuel tank capacity and tank configuration to the designed wing.
(amended 2009/05/11)

(ii) Fleet Average Flammability Exposure is defined in Appendix N to this part and means the percentage of time each fuel tank ullage is flammable for a fleet of an aeroplane type operating over the range of flight lengths.
(amended 2009/05/11)

(iii) Main Fuel Tank means a fuel tank that feeds fuel directly into one or more engines and holds required fuel reserves continually throughout each flight.
(amended 2009/05/11)

(c) Paragraph (b) of this section does not apply to a fuel tank if means are provided to mitigate the effects of an ignition of fuel vapours within fuel tank such that no damage caused by an ignition will prevent continued safe flight and landing.
(amended 2009/05/11)

(d) Critical design configuration control limitations (CDCCL), inspections, or other procedures must be established, as necessary, to prevent development of ignition sources within the fuel tank system pursuant to (a) of this section, to prevent increasing the flammability exposure of the tanks above that permitted under (b) of this section, and to prevent degradation of the performance and reliability of any means provided under paragraphs (a) or (c) of this section. These CDCCL, inspections and procedures must be included in the Airworthiness Limitations section of the Instructions for Continued Airworthiness required by 525.1529. Visible means to identify critical features of the design

must be placed in areas of the aeroplane where maintenance actions, repairs, or alterations may compromise the critical design configuration limitations (e.g., colour-coding of wire to identify separation limitation). These visible means must also be identified as CDCCL. (amended 2009/05/11)

Fuel System Components

525.991 *Fuel Pumps*

(a) Main pumps. Each fuel pump required for proper engine operation, or required to meet the fuel system requirements of this subchapter (other than those in paragraph *(b)* of this section), is a main pump. For each main pump, provision must be made to allow the bypass of each positive displacement fuel pump other than a fuel injection pump (a pump that supplies the proper flow and pressure for fuel injection when the injection is not accomplished in a carburettor) approved as part of the engine.

(b) Emergency pumps. There must be emergency pumps or another main pump to feed each engine immediately after failure of any main pump (other than a fuel injection pump approved as part of the engine).

525.993 *Fuel System Lines and Fittings*

(a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.

(b) Each fuel line connected to components of the aeroplane between which relative motion could exist must have provisions for flexibility.

(c) Each flexible connection in fuel lines that may be under pressure and subjected to axial loading must use flexible hose assemblies.

(d) Flexible hose must be approved or must be shown to be suitable for the particular application.

(e) No flexible hose that might be adversely affected by exposure to high temperatures may be used where excessive temperatures will exist during operation or after engine shut-down.

(f) Each fuel line within the fuselage must be designed and installed to allow a reasonable degree of deformation and stretching without leakage.

525.994 *Fuel System Components*

Fuel system components in an engine nacelle or in the fuselage must be protected from damage which could result in spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway.

525.995 *Fuel Valves*

In addition to the requirements of 525.1189 for shut-off means, each fuel valve must:

(a) (Reserved)

(b) Be supported so that no loads resulting from their operation or from accelerated flight conditions are transmitted to the lines attached to the valve.

525.997 *Fuel Strainer or Filter*

There must be a fuel strainer or filter between the fuel tank outlet and the inlet of either the fuel metering device or an engine driven positive displacement pump, whichever is nearer the fuel tank outlet. This fuel strainer or filter must:

(a) Be accessible for draining and cleaning and must incorporate a screen or element which is easily removable;

(b) Have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes;

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

(d) Have the capacity (with respect to operating limitations established for the engine) to ensure that engine fuel system functioning is not impaired, with the fuel contaminated to a degree (with respect to particle size and density) that is greater than that established for the engine in Chapter 533 of this manual.

525.999 *Fuel System Drains*

(a) Drainage of the fuel system must be accomplished by the use of fuel strainer and fuel tank sump drains.

(b) Each drain required by paragraph *(a)* of this section must:

(1) Discharge clear of all parts of the aeroplane:

(2) Have manual or automatic means for positive locking in the closed position; and

(3) Have a drain valve:

(i) That is readily accessible and which can be easily opened and closed; and

(ii) That is either located or protected to prevent fuel spillage in the event of a landing with landing gear retracted.

525.1001 *Fuel Jettisoning System*

(a) A fuel jettisoning system must be installed on each aeroplane unless it is shown that the aeroplane meets the climb requirements of 525.119 and 525.121*(d)* at maximum take-off weight, less the actual or computed weight of fuel necessary for a 15 minute flight comprised of a take-off, go-around, and landing at the airport of departure with the aeroplane configuration, speed, power, and thrust the same as that used in meeting the applicable take-off, approach, and landing climb performance requirements of this chapter.

(b) If a fuel jettisoning system is required it must be capable of jettisoning enough fuel within 15 minutes, starting with the weight given in paragraph *(a)* of this section, to enable the aeroplane to meet the climb requirements of 525.119 and 525.121*(d)*, assuming that the fuel is jettisoned under the conditions, except weight, found least favourable during the flight tests prescribed in paragraph *(c)* of this section.

(c) Fuel jettisoning shall be demonstrated beginning at maximum take-off weight with flaps and landing gear up and in:
(amended 2003/11/10)

(1) A power-off glide at 1.3 V_{SR1};
(amended 2003/11/10)

(2) A climb at the one-engine inoperative best rate-of-climb speed, with the critical engine inoperative and the remaining engines at maximum continuous power; and

(3) Level flight at 1.3 V_{SR1}; if the results of the tests in the conditions specified in paragraphs (c)(1) and (2) of this section demonstrate that this condition could be critical.
(amended 2003/11/10)

(d) During the flight tests prescribed in paragraph *(c)* of this section, it must be shown that:

(1) The fuel jettisoning system and its operation are free from fire hazard;

(2) The fuel discharges clear of any part of the aeroplane;

(3) Fuel or fumes do not enter any parts of the aeroplane; and

(4) The jettisoning operation does not adversely affect the controllability of the aeroplane.

(e) For reciprocating engine powered aeroplanes, means must be provided to prevent jettisoning the fuel in the tanks used for take-off and landing below the level allowing 45 minutes flight at 75 percent maximum continuous power. However, if there is an auxiliary control independent of the main jettisoning control, the system may be designed to jettison the remaining fuel by means of the auxiliary jettisoning control.

(f) For turbine engine powered aeroplanes, means must be provided to prevent jettisoning the fuel in the tanks used for take-off and landing below the level allowing climb from sea level to 10,000 feet and thereafter allowing 45 minutes cruise at a speed for maximum range. However, if there is an auxiliary control independent of the main jettisoning control, the system may be designed to jettison the remaining fuel by means of the auxiliary jettisoning control.

(g) The fuel jettisoning valve must be designed to allow flight personnel to close the valve during any part of the jettisoning operation.

(h) Unless it is shown that using any means (including flaps, slots, and slats) for changing the airflow across or around the wings does not adversely affect fuel jettisoning, there must be a placard, adjacent to the jettisoning control, to warn flight crew members against jettisoning fuel while the means that change the airflow are being used.

(i) The fuel jettisoning system must be designed so that any reasonably probable single malfunction in the system will not result in a hazardous condition due to unsymmetrical jettisoning of, or inability to jettison, fuel.

Oil System

525.1011 *General*

(a) Each engine must have an independent oil system that can supply it with an appropriate quantity of oil at a temperature not above that safe for continuous operation.

(b) The usable oil capacity may not be less than the product of the endurance of the aeroplane under critical operating conditions and the approved maximum allowable oil consumption of the engine under the same conditions, plus a suitable margin to ensure system circulation. Instead of a rational analysis of aeroplane range for the purpose of computing oil requirements for reciprocating engine powered aeroplanes, the following fuel/oil ratios may be used:

(1) For aeroplanes without a reserve oil or oil transfer system, a fuel/oil ratio of 30:

1 by volume.

(2) For aeroplanes with either a reserve oil or oil transfer system, a fuel/oil ratio of 40:

1 by volume.

(c) Fuel/oil ratios higher than those prescribed in paragraphs *(b)*(1) and (2) of this section may be used if substantiated by data on actual engine oil consumption.

525.1013 *Oil Tanks*

(a) Installation. Each oil tank installation must meet the requirements of 525.967.

(b) Expansion space. Oil tank expansion space must be provided as follows:

(1) Each oil tank used with a reciprocating engine must have an expansion space of not less than the greater of 10 percent of the tank capacity or 0.5 gallon, and each oil tank used with a turbine engine must have an expansion space of not less than 10 percent of the tank capacity.

(2) Each reserve oil tank not directly connected to any engine may have an expansion space of not less than two percent of the tank capacity.

(3) It must be impossible to fill the expansion space inadvertently with the aeroplane in the normal ground attitude.

(c) Filler connection. Each recessed oil tank filler connection that can retain any appreciable quantity of oil must have a drain that discharges clear of each part of the aeroplane. In addition each oil tank filler cap must provide an oil-tight seal.

(d) Vent. Oil tanks must be vented as follows:

(1) Each oil tank must be vented from the top part of the expansion space so that venting is effective under any normal flight condition.

(2) Oil tank vents must be arranged so that condensed water vapour that might freeze and obstruct the line cannot accumulate at any point.

(e) Outlet. There must be means to prevent entrance into the tank itself, or into the tank outlet, of any object that might obstruct the flow of oil through the system. No oil tank outlet may be enclosed by any screen or guard that would reduce the flow of oil below a safe value at any operating temperature. There must be a shut-off valve at the outlet of each oil tank used with a turbine engine, unless the external portion of the oil system (including the oil tank supports) is fireproof.

(f) Flexible oil tank liners. Each flexible oil tank liner must be approved or must be shown to be suitable for the particular application.

(Change 525-3 (91-11-01))

525.1015 *Oil Tank Tests*

Each oil tank must be designed and installed so that:

(a) It can withstand, without failure, each vibration, inertia, and fluid load that it may be subjected to in operation; and

(b) It meets the provisions of 525.965, except:

(1) The test pressure:

(i) For pressurised tanks used with a turbine engine, may not be less than 5 p.s.i. plus the maximum operating pressure of the tank instead of the pressure specified in 525.965(a); and

(ii) For all other tanks may not be less than 5 p.s.i. instead of the pressure specified in 525.965(a); and

(2) The test fluid must be oil at 250°F instead of the fluid specified in 525.965(c).

525.1017 *Oil Lines and Fittings*

(a) Each oil line must meet the requirements of 525.993 and each oil line and fitting in any designated fire zone must meet the requirements of 525.1183.

(b) Breather lines must be arranged so that:

(1) Condensed water vapour that might freeze and obstruct the line cannot accumulate at any point;

(2) The breather discharge does not constitute a fire hazard if foaming occurs or causes emitted oil to strike the pilot's windshield; and

(3) The breather does not discharge into the engine air induction system.

525.1019 *Oil Strainer or Filter*

(a) Each turbine engine installation must incorporate an oil strainer or filter through which all of the engine oil flows and which meets the following requirements:

(1) Each oil strainer or filter that has a bypass, must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter completely blocked.

(2) The oil strainer or filter must have the capacity (with respect to operating limitations established for the engine) to ensure that engine oil system functioning is not impaired when the oil is contaminated to a degree (with respect to particle size and density) that is greater than that established for the engine under Chapter 533 of this manual.

(3) The oil strainer or filter, unless it is installed at an oil tank outlet, must incorporate an indicator that will indicate contamination before it reaches the capacity established in accordance with subparagraph (2) of this paragraph.

(4) The bypass of a strainer or filter must be constructed and installed so that the release of collected contaminants is minimised by appropriate location of the bypass to ensure that collected contaminants are not in the bypass flow path.

(5) An oil strainer or filter that has no bypass, except one that is installed at an oil tank outlet, must have a means to connect it to the warning system required in 525.1305(c)(7).

(b) Each oil strainer or filter in a powerplant installation using reciprocating engines must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter element completely blocked.

525.1021 *Oil System Drains*

A drain (or drains) must be provided to allow safe drainage of the oil system. Each drain must:

(a) Be accessible; and

(b) Have manual or automatic means for positive locking in the closed position.

525.1023 *Oil Radiators*

(a) Each oil radiator must be able to withstand, without failure, any vibration, inertia, and oil pressure load to which it would be subjected in operation.

(b) Each oil radiator air duct must be located so that, in case of fire, flames coming from normal openings of the engine nacelle cannot impinge directly upon the radiator.

525.1025 *Oil Valves*

(a) Each oil shut-off must meet the requirements of 525.1189.

(b) The closing of oil shut-off means may not prevent propeller feathering.

(c) Each oil valve must have positive stops or suitable index provisions in the "on" and "off" positions and must be supported so that no loads resulting from its operation or from accelerated flight conditions are transmitted to the lines attached to the valve.

525.1027 *Propeller Feathering System*

(a) If the propeller feathering system depends on engine oil, there must be means to trap an amount of oil in the tank if the supply becomes depleted due to failure of any part of the lubricating system other than the tank itself.

(b) The amount of trapped oil must be enough to accomplish the feathering operation and must be available only to the feathering pump.

(c) The ability of the system to accomplish feathering with the trapped oil must be shown. This may be done on the ground using an auxiliary source of oil for lubricating the engine during operation.

(d) Provision must be made to prevent sludge or other foreign matter from affecting the safe operation of the propeller feathering system.

Cooling

525.1041 *General*

The powerplant and auxiliary power unit cooling provisions must be able to maintain the temperatures of powerplant components, engine fluids, and auxiliary power unit components and fluids within the temperature limits established for these components and fluids, under ground, water, and flight operating conditions, and after normal engine or auxiliary power unit shutdown, or both.

525.1043 *Cooling Tests*

(a) General. Compliance with 525.1041 must be shown by tests, under critical ground, water, and flight operating conditions. For these tests, the following apply:

(1) If the tests are conducted under conditions deviating from the maximum ambient atmospheric temperature, the recorded powerplant temperatures must be corrected under paragraphs (c) and (d) of this section.

(2) No corrected temperatures determined under subparagraph (1) of this paragraph may exceed established limits.

(3) For reciprocating engines, the fuel used during the cooling tests must be the minimum grade approved for the engines, and the mixture settings must be those normally used in the flight stages for which the cooling tests are conducted. The test procedures must be as prescribed in 525.1045.

(b) Maximum ambient atmospheric temperature. A maximum ambient atmospheric temperature corresponding to sea level conditions of at least 100 degrees F must be established. The assumed temperature lapse rate is 3.6 degrees F per thousand feet of altitude above sea level until a temperature of -69.7 degrees F is reached, above which altitude the temperature is considered constant at -69.7 degrees F. However, for winterisation installations, the applicant may select a maximum ambient atmospheric temperature corresponding to sea level conditions of less than 100 degrees F.

(c) Correction factor (except cylinder barrels). Unless a more rational correction applies, temperatures of engine fluids and powerplant components (except cylinder barrels) for which temperature limits are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum component or fluid temperature recorded during the cooling test.

(d) Correction factor for cylinder barrel temperatures. Unless a more rational correction applies, cylinder barrel temperatures must be corrected by adding to them 0.7 times the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum cylinder barrel temperature recorded during the cooling test.

525.1045 *Cooling Test Procedures*

(a) Compliance with 525.1041 must be shown for the take-off, climb, en route, and landing stages of flight that correspond to the applicable performance requirements. The cooling tests must be conducted with the aeroplane in the configuration, and operating under the conditions,

that are critical relative to cooling during each stage of flight. For the cooling tests, a temperature is "stabilised" when its rate of change is less than two degrees F per minute.

(b) Temperatures must be stabilised under the conditions from which entry is made into each stage of flight being investigated, unless the entry condition normally is not one during which component and engine fluid temperatures would stabilise (in which case, operation through the full entry condition must be conducted before entry into the stage of flight being investigated in order to allow temperatures to reach their natural levels at the time of entry). The take-off cooling test must be preceded by a period during which the powerplant component and engine fluid temperatures are stabilised with the engines at ground idle.

(c) Cooling tests for each stage of flight must be continued until:

(1) The component and engine fluid temperatures stabilise;

(2) The stage of flight is completed; or

(3) An operating limitation is reached.

(d) For reciprocating engine powered aeroplanes, it may be assumed, for cooling test purposes, that the take-off stage of flight is complete when the aeroplane reaches an altitude of 1,500 feet above the take-off surface or reaches a point in the take-off where the transition from the take-off to the en route configuration is completed and a speed is reached at which compliance with 525.121*(c)* is shown, whichever point is at a higher altitude. The aeroplane must be in the following configuration:

(1) Landing gear retracted.

(2) Wing flaps in the most favourable position.

(3) Cowl flaps (or other means of controlling the engine cooling supply) in the position that provides adequate cooling in the hot-day condition.

(4) Critical engine inoperative and its propeller stopped.

(5) Remaining engines at the maximum continuous power available for the altitude.

(e) For hull seaplanes and amphibians, cooling must be shown during taxiing downwind for 10 minutes, at 5 knots above step speed.

Induction System

525.1091 *Air Induction*

(a) The air induction system for each engine and auxiliary power unit must supply:

(1) The air required by the engine and auxiliary power unit under each operating condition for which certification is requested; and

(2) The air for proper fuel metering and mixture distribution with the induction system valves in any position.

(b) Each reciprocating engine must have an alternate air source that prevents the entry of rain, ice, or any other foreign matter.

(c) Air intakes may not open within the cowling, unless:

(1) That part of the cowling is isolated from the engine accessory section by means of a fireproof diaphragm; or

(2) For reciprocating engines, there are means to prevent the emergence of backfire flames.

(d) For turbine engine powered aeroplanes and aeroplanes incorporating auxiliary power units:

(1) There must be means to prevent hazardous quantities of fuel leakage or overflow from drains, vents, or other components of flammable fluid systems from entering the engine or auxiliary power unit intake system; and

(2) The aeroplane must be designed to prevent water or slush on the runway, taxiway, or other airport operating surfaces from being directed into the engine or auxiliary power unit air inlet ducts in hazardous quantities, and the air inlet ducts must be located or protected so as to minimize the ingestion of foreign matter during take-off, landing, and taxiing.

(e) If the engine induction system contains parts or components that could be damaged by foreign objects entering the air inlet, it must be shown by tests or, if appropriate, by analysis that the induction system design can withstand the foreign object ingestion test conditions of sections 533.76, 533.77 and paragraph 533.78*(a)*(1) of this manual without failure of parts or components that could create a hazard.
(amended 2001/03/05)

525.1093 *Induction System De-icing and Anti-icing Provisions*

(a) Reciprocating engines. Each reciprocating engine air induction system must have means to prevent and eliminate icing. Unless this is done by other means, it must be shown that, in air free of visible moisture at a temperature of 30°F, each aeroplane with altitude engines using:

(1) Conventional venturi carburettors have a preheater that can provide a heat rise of 120°F with the engine at 60 percent of maximum continuous power; or

(2) Carburettors tending to reduce the probability of ice formation has a preheater that can provide a heat rise of 100°F with the engine at 60 percent of maximum continuous power.

(b) Turbine engines.

(1) Each turbine engine and its air inlet system must operate throughout the flight power range of the engine (including idling), without the accumulation of ice on the engine, inlet system components, or airframe components that would adversely affect engine operation or cause a serious loss of power or thrust:

(i) Under the icing conditions specified in Appendix C; and

(ii) In falling and blowing snow within the limitations established for the aeroplane for such operation.

(2) Each turbine engine must idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between 15° and 30°F (between -9° and -1°C) and has a liquid water content not less than 0.3 grams per cubic metre in the form of drops having a mean effective diameter not less than 20 microns, followed by momentary operation at take-off

power or thrust. During the 30 minutes of idle operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Minister.

(c) Supercharged reciprocating engines. For each engine having a supercharger to pressurise the air before it enters the carburettor, the heat rise in the air caused by that supercharging at any altitude may be utilised in determining compliance with paragraph *(a)* of this section if the heat rise utilised is that which will be available, automatically, for the applicable altitude and operating condition because of supercharging.

(Change 525-3 (91-11-01))

525.1101 *Carburettor Air Preheater Design*

Each carburettor air preheater must be designed and constructed to:

(a) Ensure ventilation of the preheater when the engine is operated in cold air;

(b) Allow inspection of the exhaust manifold parts that it surrounds; and

(c) Allow inspection of critical parts of the preheater itself.

525.1103 *Induction System Ducts and Air Duct Systems*

(a) Each induction system duct upstream of the first stage of the engine supercharger and of the auxiliary power unit compressor must have a drain to prevent the hazardous accumulation of fuel and moisture in the ground attitude. No drain may discharge where it might cause a fire hazard.

(b) Each induction system duct must be:

(1) Strong enough to prevent induction system failures resulting from normal backfire conditions; and

(2) Fire resistant if it is in any fire zone for which a fire-extinguishing system is required, except that ducts for auxiliary power units must be fireproof within the auxiliary power unit fire zone.

(c) Each duct connected to components between which relative motion could exists must have means for flexibility.

(d) For turbine engine and auxiliary power unit bleed air duct systems, no hazard may result if a duct failure occurs at any point between the air duct source and the aeroplane unit served by the air.

(e) Each auxiliary power unit induction system duct must be fireproof for a sufficient distance upstream of the auxiliary power unit compartment to prevent hot gas reverse flow from burning through auxiliary power unit ducts and entering any other compartment or area of the aeroplane in which a hazard would be created resulting from the entry of hot gases. The materials used to form the remainder of the induction system duct and plenum chamber of the auxiliary power unit must be capable of resisting the maximum heat conditions likely to occur.

(f) Each auxiliary power unit induction system duct must be constructed of materials that will not absorb or trap hazardous quantities of flammable fluids that could be ignited in the event of a surge or reverse flow condition.

525.1105 *Induction System Screens*

If induction system screens are used:

(a) Each screen must be upstream of the carburettor;

(b) No screen may be in any part of the induction system that is the only passage through which air can reach the engine, unless it can be de-iced by heated air;

(c) No screen may be de-iced by alcohol alone; and

(d) It must be impossible for fuel to strike any screen.

525.1107 *Inter-coolers and After-coolers*

Every inter-cooler and after-cooler must be able to withstand any vibration, inertia, and air pressure load to which it would be subjected in operation.

Exhaust System

525.1121 *General*

For powerplant and auxiliary power unit installations the following apply:

(a) Each exhaust system must ensure safe disposal of exhaust gases without fire hazard or carbon monoxide contamination in any personnel compartment. For test purposes, any acceptable carbon monoxide detection method may be used to show the absence of carbon monoxide.

(b) Each exhaust system part with a surface hot enough to ignite flammable fluids or vapours must be located or shielded so that leakage from any system carrying flammable fluids or vapours will not result in a fire caused by impingement of the fluids or vapours on any part of the exhaust system including shields for the exhaust system.

(c) Each component that hot exhaust gases could strike, or that could be subjected to high temperatures from exhaust system parts, must be fireproof. All exhaust system components must be separated by fireproof shields from adjacent parts of the aeroplane that are outside the engine and auxiliary power unit compartments.

(d) No exhaust gases may discharge so as to cause a fire hazard with respect to any flammable fluid vent or drain.

(e) No exhaust gases may discharge where they will cause a glare seriously affecting pilot vision at night.

(f) Each exhaust system component must be ventilated to prevent points of excessively high temperature.

(g) Each exhaust shroud must be ventilated or insulated to avoid, during normal operation, a temperature high enough to ignite any flammable fluids or vapours external to the shroud.

525.1123 *Exhaust Piping*

For powerplant and auxiliary power unit installations, the following apply:

(a) Exhaust piping must be heat and corrosion resistant, and must have provisions to prevent failure due to expansion by operating temperatures.

(b) Piping must be supported to withstand any vibration and inertia loads to which it would be subjected in operation; and

(c) Piping connected to components between which relative motion could exist must have means for flexibility.

525.1125 *Exhaust Heat Exchangers*

For reciprocating engine powered aeroplanes, the following apply:

(a) Each exhaust heat exchanger must be constructed and installed to withstand each vibration, inertia, and other load to which it would be subjected in operation. In addition:

(1) Each exchanger must be suitable for continued operation at high temperatures and resistant to corrosion from exhaust gases;

(2) There must be means for the inspection of the critical parts of each exchanger;

(3) Each exchanger must have cooling provisions wherever it is subject to contact with exhaust gases; and

(4) No exhaust heat exchanger or muff may have any stagnant areas or liquid traps that would increase the probability of ignition of flammable fluids or vapours that might be present in case of the failure or malfunction of components carrying flammable fluids.

(b) If an exhaust heat exchanger is used for heating ventilating air:

(1) There must be a secondary heat exchanger between the primary exhaust gas heat exchanger and the ventilating air system; or

(2) Other means must be used to preclude the harmful contamination of the ventilating air.

525.1127 *Exhaust Driven Turbo-Superchargers*

(a) Each exhaust driven turbo-supercharger must be approved or shown to be suitable for the particular application. It must be installed and supported to ensure safe operation between normal inspections and overhauls. In addition, there must be provisions for expansion and flexibility between exhaust conduits and the turbine.

(b) There must be provisions for lubricating the turbine and for cooling turbine parts where temperatures are critical.

(c) If the normal turbo-supercharger control system malfunctions, the turbine speed may not exceed its maximum allowable value. Except for the waste gate operating components, the components provided for meeting this requirement must be independent of the normal turbo-supercharger controls.

Powerplant Controls and Accessories

525.1141 *Powerplant Controls: General*

Each powerplant control shall be located, arranged, and designed under 525.777 through 525.781 and marked under 525.1555. In addition, it shall meet the following requirements:
(amended 2005/06/03)

(a) Each control shall be located so that it cannot be inadvertently operated by persons entering, leaving, or moving normally in, the cockpit.
(amended 2005/06/03)

(b) Each flexible control shall be approved or shall be shown to be suitable for the particular application.
(amended 2005/06/03)

(c) Each control shall have sufficient strength and rigidity to withstand operating loads without failure and without excessive deflection.
(amended 2005/06/03)

(d) Each control shall be able to maintain any set position without constant attention by flight crew members and without creep due to control loads or vibration.
(amended 2005/06/03)

(e) The portion of each powerplant control located in a designated fire zone that is required to be operated in the event of fire shall be at least fire resistant.
(amended 2005/06/03)

(f) For powerplant valve controls located in the flight deck there shall be a means:
(amended 2005/06/03)

(1) For the flight crew to select each intended position or function of the valve; and
(amended 2005/06/03)

(2) To indicate to the flight crew:
(amended 2005/06/03)

(i) The selected position or function of the valve; and
(amended 2005/06/03)

(ii) When the valve has not responded as intended to the selected position or function.
(amended 2005/06/03)

(Change 525-3 (91-11-01))

525.1142 *Auxiliary Power Unit Controls*

Means must be provided on the flight deck for starting, stopping, and emergency shutdown of each installed auxiliary power unit.

525.1143 *Engine Controls*

(a) There must be a separate power or thrust control for each engine.

(b) Power and thrust controls must be arranged to allow:

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(c) Each power and thrust control must provide a positive and immediately responsive means of controlling its engine.

(d) For each fluid injection (other than fuel) system and its controls not provided and approved as part of the engine, the applicant must show that the flow of the injection fluid is adequately controlled.

(e) If a power or thrust control incorporates a fuel shut-off feature, the control must have a means to prevent the inadvertent movement of the control into the shut-off position. The means must:

(1) Have a positive lock or stop at the idle position; and

(2) Require a separate and distinct operation to place the control in the shut-off position.

525.1145 *Ignition Switches*

(a) Ignition switches must control each engine ignition circuit on each engine.

(b) There must be means to quickly shut off all ignition by the grouping of switches or by a master ignition control.

(c) Each group of ignition switches, except ignition switches for turbine engines for which continuous ignition is not required, and each master ignition control must have a means to prevent its inadvertent operation.

525.1147 *Mixture Controls*

(a) If there are mixture controls, each engine must have a separate control. The controls must be grouped and arranged to allow:

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(b) Each intermediate position of the mixture controls that corresponds to a normal operating setting must be identifiable by feel and sight.

(c) The mixture controls must be accessible to both pilots. However, if there is a separate flight engineer station with a control panel, the controls need be accessible only to the flight engineer.

525.1149 *Propeller Speed and Pitch Controls*

(a) There must be a separate propeller speed and pitch control for each propeller.

(b) The controls must be grouped and arranged to allow:

(1) Separate control of each propeller; and

(2) Simultaneous control of all propellers.

(c) The controls must allow synchronisation of all propellers.

(d) The propeller speed and pitch controls must be to the right of, and at least one inch below, the pilot's throttle controls.

525.1153 *Propeller Feathering Controls*

(a) There must be a separate propeller feathering control for each propeller. The control must have means to prevent its inadvertent operation.

(b) If feathering is accomplished by movement of the propeller pitch or speed control lever, there must be means to prevent the inadvertent movement of this lever to the feathering position during normal operation.

525.1155 *Reverse Thrust and Propeller Pitch Settings Below the Flight Regime*

Each control for reverse thrust and for propeller pitch settings below the flight regime must have means to prevent its inadvertent operation. The means must have a positive lock or stop at the flight idle position and must require a separate and distinct operation by the crew to displace the control from the flight regime (forward thrust engine regime for turbojet powered aeroplanes).

525.1157 *Carburettor Air Temperature Controls*

There must be a separate carburettor air temperature control for each engine.

525.1159 *Supercharger Controls*

Each supercharger control must be accessible to the pilots or, if there is a separate flight engineer station with a control panel, to the flight engineer.

525.1161 *Fuel Jettisoning System Controls*

Each fuel jettisoning system control must have guards to prevent inadvertent operation. No control may be near any fire extinguisher control or other control used to combat fire.

525.1163 *Powerplant Accessories*

(a) Each engine-mounted accessory must:

(1) Be approved for mounting on the engine involved;

(2) Use the provisions on the engine for mounting; and

(3) Be sealed to prevent contamination of the engine oil system and the accessory system.

(b) Electrical equipment subject to arcing or sparking must be installed to minimise the probability of contact with any flammable fluids or vapours that might be present in a free state.

(c) If continued rotation of an engine-driven cabin supercharger or of any remote accessory driven by the engine is hazardous if malfunctioning occurs, there must be means to prevent rotation without interfering with the continued operation of the engine.

525.1165 *Engine Ignition Systems*

(a) Each battery ignition system must be supplemented by a generator that is automatically available as an alternate source of electrical energy to allow continued engine operation if any battery becomes depleted.

(b) The capacity of batteries and generators must be large enough to meet the simultaneous demands of the engine ignition system and the greatest demands of any electrical system components that draw electrical energy from the same source.

(c) The design of the engine ignition system must account for:

(1) The condition of an inoperative generator;

(2) The condition of a completely depleted battery with the generator running at its normal operating speed; and

(3) The condition of a completely depleted battery with the generator operating at idling speed, if there is only one battery.

(d) Magneto ground wiring (for separate ignition circuits) that lies on the engine side of the fire wall, must be installed, located, or protected, to minimise the probability of simultaneous failure of two or more wires as a result of mechanical damage, electrical faults, or other cause.

(e) No ground wire for any engine may be routed through a fire zone of another engine unless each part of that wire within that zone is fireproof.

(f) Each ignition system must be independent of any electrical circuit not used for assisting, controlling, or analysing the operation of that system.

(g) There must be means to warn appropriate flight crew members if the malfunctioning of any part of the electrical system is causing the continuous discharge of any battery necessary for engine ignition.

(h) Each engine ignition system of a turbine powered aeroplane must be considered an essential electrical load.

(Change 525-3 (91-11-01))

525.1167 *Accessory Gearboxes*

For aeroplanes equipped with an accessory gearbox that is not certified as part of an engine:

(a) The engine with gearbox and connecting transmissions and shafts attached must be subjected to the tests specified in 533.49 or 533.87 of this manual as applicable.

(b) The accessory gearbox must meet the requirements of 533.25 and 533.53 or 533.91 of this manual as applicable; and

(c) Possible misalignments and torsional loadings of the gearbox, transmission, and shaft system, expected to result under normal operating conditions must be evaluated.

Powerplant Fire Protection

525.1181 *Designated Fire Zones; Regions Included*

(a) Designated fire zones are:

(1) The engine power section;

(2) The engine accessory section;

(3) Except for reciprocating engines, any complete powerplant compartments in which no isolation is provided between the engine power section and the engine accessory section;

(4) Any auxiliary power unit compartment;

(5) Any fuel-burning heater and other combustion equipment installation described in 525.859.

(6) The compressor and accessory sections of turbine engines; and

(7) Combustor, turbine, and tailpipe sections of turbine engine installations that contain lines or components carrying flammable fluids or gases.

(b) Each designated fire zone shall meet the requirements of 525.863, 525.865, 525.867, 525.869 and 525.1185 through 525.1203.
(amended 2005/06/03)

(Change 525-3 (91-11-01))

525.1182 *Nacelle Areas Behind Firewalls, and Engine Pod Attaching Structures Containing Flammable Fluid Lines*

(a) Each nacelle area immediately behind the firewall, and each portion of any engine pod attaching structure containing flammable fluid lines, must meet each requirement of 525.1103*(b)*, 525.1165*(d)* and *(e)*, 525.1183, 525.1185*(c)*, 525.1187, 525.1189, and 525.1195 through 525.1203, including those concerning designated fire zones. However, engine pod attaching structures need not contain fire detection or extinguishing means.

(b) For each area covered by paragraph *(a)* of this section that contains a retractable landing gear, compliance with that paragraph need only be shown with the landing gear retracted.

525.1183 *Flammable Fluid-Carrying Components*

(a) Except as provided in paragraph *(b)* of this section, each line, fitting, and other component carrying flammable fluid in any area subject to engine fire conditions, and each component which conveys or contains flammable fluid in a designated fire zone must be fire resistant, except that flammable fluid tanks and supports in a designated fire zone must be fireproof or be enclosed by a fireproof shield unless damage by fire to any non-fireproof part will not cause leakage or spillage of flammable fluid. Components must be shielded or located to safeguard against the ignition of leaking flammable fluid. An integral oil sump of less than 25 quart capacity on a reciprocating engine need not be fireproof nor be enclosed by a fireproof shield.

(b) Paragraph *(a)* of this section does not apply to:

(1) Lines, fittings, and components which are already approved as part of a type certificated engine; and

(2) Vent and drain lines, and their fittings, whose failure will not result in, or add to, a fire hazard.

(c) All components, including ducts, within a designated fire zone shall be fireproof if, when exposed to or damaged by fire, they could:
(amended 2001/05/07)

(1) result in fire spreading to other regions of the aeroplane; or

(2) cause unintentional operation of, or inability to operate, essential services or equipment.

525.1185 *Flammable Fluids*

(a) Except for the integral oil sumps specified in 525.1183*(a)*, no tank or reservoir that is a part of a system containing flammable fluids or gases may be in a designated fire zone unless

the fluid contained, the design of the system, the materials used in the tank, the shut-off means, and all connections, lines, and control provide a degree of safety equal to that which would exist if the tank or reservoir were outside such a zone.

(b) There must be at least one-half inch of clear airspace between each tank or reservoir and each firewall or shroud isolating a designated fire zone.

(c) Absorbent materials close to flammable fluid system components that might leak must be covered or treated to prevent the absorption of hazardous quantities of fluids.

525.1187 *Drainage and Ventilation of Fire Zones*

(a) There must be complete drainage of each part of each designated fire zone to minimise the hazards resulting from failure or malfunctioning of any component containing flammable fluids. The drainage means must be:

(1) Effective under conditions expected to prevail when drainage is needed; and

(2) Arranged so that no discharged fluid will cause an additional fire hazard.

(b) Each designated fire zone must be ventilated to prevent the accumulation of flammable vapours.

(c) No ventilation opening may be where it would allow the entry of flammable fluids, vapours, or flame from other zones.

(d) Each ventilation means must be arranged so that no discharged vapours will cause an additional fire hazard.

(e) Unless the extinguishing agent capacity and rate of discharge are based on maximum air flow through a zone, there must be means to allow the crew to shut off sources of forced ventilation to any fire zone except the engine power section of the nacelle and the combustion heater ventilating air ducts.

525.1189 *Shut-off Means*

(a) Each engine installation and each fire zone specified in 525.1181*(a)*(4) and (5) must have a means to shut off or otherwise prevent hazardous quantities of fuel, oil, de-icer, and other flammable fluids, from flowing into, within, or through any designated fire zone, except that shut-off means are not required for:

(1) Lines, fittings, and components forming an integral part of an engine; and

(2) Oil systems for turbine engine installations in which all components of the system in a designated fire zone, including oil tanks, are fireproof or located in areas not subject to engine fire conditions.

(b) The closing of any fuel shut-off valve for any engine may not make fuel unavailable to the remaining engines.

(c) Operation of any shut-off may not interfere with the later emergency operation of other equipment, such as the means for feathering the propeller.

(d) Each flammable fluid shut-off means and control must be fireproof or must be located and protected so that any fire in a fire zone will not affect its operation.

(e) No hazardous quantity of flammable fluid may drain into any designated fire zone after shut-off.

(f) There must be means to guard against inadvertent operation of the shut-off means and to make it possible for the crew to reopen the shut-off means in flight after it has been closed.

(g) Each tank-to-engine shut-off valve must be located so that the operation of the valve will not be affected by powerplant or engine mount structural failure.

(h) Each shut-off valve must have a means to relieve excessive pressure accumulation unless a means for pressure relief is otherwise provided in the system.

525.1191 *Firewalls*

(a) Each engine, auxiliary power unit, fuel-burning heater, other combustion equipment intended for operation in flight, and the combustion, turbine, and tailpipe sections of turbine engines, must be isolated from the rest of the aeroplane by firewalls, shrouds, or equivalent means.

(b) Each firewall and shroud must be:

(1) Fireproof;

(2) Constructed so that no hazardous quantity of air, fluid, or flame can pass from the compartment to other parts of the aeroplane;

(3) Constructed so that each opening is sealed with close fitting fireproof grommets, bushings, or firewall fittings, and;

(4) Protected against corrosion.

525.1192 *Engine Accessory Section Diaphragm*

For reciprocating engines, the engine power section and all portions of the exhaust system must be isolated from the engine accessory compartment by a diaphragm that complies with the firewall requirements of 525.1191.

525.1193 *Cowling and Nacelle Skin*

(a) Each cowling must be constructed and supported so that it can resist any vibration, inertia, and air load to which it may be subjected in operation.

(b) Cowling must meet the drainage and ventilation requirements of 525.1187.

(c) On aeroplanes with a diaphragm isolating the engine power section from the engine accessory section, each part of the accessory section cowling subject to flame in case of fire in the engine power section of the powerplant must:

(1) Be fireproof; and

(2) Meet the requirements of 525.1191.

(d) Each part of the cowling subject to high temperatures due to its nearness to exhaust system parts or exhaust gas impingement must be fireproof.

(e) Each aeroplane must:

(1) Be designed and constructed so that no fire originating in any fire zone can enter, either through openings or by burning through external skin, any other zone or region where it would create additional hazards;

(2) Meet subparagraph (1) of this paragraph with the landing gear retracted (if applicable); and

(3) Have fireproof skin in areas subject to flame if a fire starts in the engine power or accessory sections.

525.1195 *Fire Extinguishing Systems*

(a) Except for combustor, turbine, and tailpipe sections of turbine engine installations that contain lines or components carrying flammable fluids or gases for which it is shown that a fire originating in these sections can be controlled, there must be a fire extinguisher system serving each designated fire zone.

(b) The fire extinguishing system, the quantity of the extinguishing agent, the rate of discharge, and the discharge distribution must be adequate to extinguish fires. It must be shown by either actual or simulated flight tests that under critical airflow conditions in flight the discharge of the extinguishing agent in each designated fire zone specified in paragraph *(a)* of this section will provide an agent concentration capable of extinguishing fires in that zone and of minimising the probability of reignition. An individual "one-shot" system may be used for auxiliary power units, fuel burning heaters, and other combustion equipment. For each other designated fire zone, two discharges must be provided each of which produces adequate agent concentration.

(c) The fire-extinguishing system for a nacelle must be able to simultaneously protect each zone of the nacelle for which protection is provided.

525.1197 *Fire Extinguishing Agents*

(a) Fire extinguishing agents must:

(1) Be capable of extinguishing flames emanating from any burning of fluids or other combustible materials in the area protected by the fire extinguishing system; and

(2) Have thermal stability over the temperature range likely to be experienced in the compartment in which they are stored.

(b) If any toxic extinguishing agent is used, provisions must be made to prevent harmful concentrations of fluid or fluid vapours (from leakage during normal operation of the aeroplane or as a result of discharging the fire extinguisher on the ground or in flight) from entering any personnel compartment, even though a defect may exist in the extinguishing system. This must be shown by test except for built-in carbon dioxide fuselage compartment fire extinguishing systems for which:

(1) Five pounds or less of carbon dioxide will be discharged, under established fire control procedures, into any fuselage compartment; or

(2) There is a protective breathing equipment for each flight crew member on flight deck duty.

525.1199 *Extinguishing Agent Containers*

(a) Each extinguishing agent container must have a pressure relief to prevent bursting of the container by excessive internal pressures.

(b) The discharge end of each discharge line from a pressure relief connection must be located so that discharge of the fire extinguishing agent would not damage the aeroplane. The line must also be located or protected to prevent clogging caused by ice or other foreign matter.

(c) There must be a means for each fire extinguishing agent container to indicate that the container has discharged or that the charging pressure is below the established minimum necessary for proper functioning.

(d) The temperature of each container must be maintained, under intended operating conditions, to prevent the pressure in the container from:

(1) Falling below that necessary to provide an adequate rate of discharge; or

(2) Rising high enough to cause premature discharge.

(e) If a pyrotechnic capsule is used to discharge the extinguishing agent, each container must be installed so that temperature conditions will not cause hazardous deterioration of the pyrotechnic capsule.

525.1201 *Fire Extinguishing System Materials*

(a) No material in any fire extinguishing system may react chemically with any extinguishing agent so as to create a hazard.

(b) Each system component in an engine compartment must be fireproof.

525.1203 *Fire Detector System*

(a) There must be approved, quick acting fire or overheat detectors in each designated fire zone, and in the combustion, turbine, and tailpipe sections of turbine engine installations, in numbers and locations ensuring prompt detection of fire in those zones.

(b) Each fire detector system must be constructed and installed so that:

(1) It will withstand the vibration, inertia, and other loads to which it may be subjected in operation;

(2) There is a means to warn the crew in the event that the sensor or associated wiring within a designated fire zone is severed at one point, unless the system continues to function as a satisfactory detection system after the severing; and

(3) There is a means to warn the crew in the event of a short circuit in the sensor or associated wiring within a designated fire zone, unless the system continues to function as a satisfactory detection system after the short circuit.

(c) No fire or overheat detector may be affected by any oil, water, other fluids, or fumes that might be present.

(d) There must be means to allow the crew to check, in flight, the functioning of each fire or overheat detector electric circuit.

(e) Components of each fire or overheat detector system in a fire zone must be fire-resistant.
(amended 2009/05/11)

(f) No fire or overheat detector system component for any fire zone may pass through another fire zone, unless:

(1) It is protected against the possibility of false warnings resulting from fires in zones through which it passes; or

(2) Each zone involved is simultaneously protected by the same detector and extinguishing system.

(g) Each fire detector system must be constructed so that when it is in the configuration for installation it will not exceed the alarm activation time approved for the detectors using the response time criteria specified in the appropriate Technical Standard Order for the detector.

(h) EWIS for each fire or overheat detector system in a fire zone must meet the requirements of 525.1731.
(amended 2009/05/11)

525.1207 *Compliance*

Unless otherwise specified, compliance with the requirements of 525.1181 through 525.1203 must be shown by a full scale fire test or by one or more of the following methods:

(a) Tests of similar powerplant configurations;

(b) Tests of components;

(c) Service experience of aircraft with similar powerplant configurations;

(d) Analysis.

SUBCHAPTER F

Equipment - General

525.1301 *Function and Installation*

(a) Each item of installed equipment must:

(1) Be of a kind and design appropriate to its intended function;

(2) Be labelled as to its identification, function, or operating limitations, or any applicable combination of these factors;

(3) Be installed according to limitations specified for that equipment; and

(4) Function properly when installed.

(b) EWIS must meet the requirements of subchapter H of this chapter.
(amended 2009/05/11)

525.1301-1 *Aeroplane Operations After Ground Cold Soak*

Substantiation of satisfactory operation of the aeroplane as a total system, by cold weather testing or by documented evidence of satisfactory operation at low temperature, is required after the aeroplane has experienced a prolonged exposure to ground ambient temperatures equal to or less than -35°C unless an alternative minimum ground ambient temperature has been proposed by the applicant and accepted by the Minister.

FAR: No equivalent text.

525.1303 *Flight and Navigation Instruments*

(a) The following flight and navigation instruments must be installed so that the instrument is visible from each pilot station:

(1) A free air temperature indicator or an air temperature indicator which provides indications that are convertible to free-air temperature.

(2) A clock displaying hours, minutes, and seconds with a sweep-second pointer or digital presentation.

(3) A direction indicator (non-stabilised magnetic compass).

(b) The following flight and navigation instruments must be installed at each pilot station:

(1) An airspeed indicator. If airspeed limitations vary with altitude, the indicator must have a maximum allowable airspeed indicator showing the variation of V_{MO} with altitude.

(2) An altimeter (sensitive).

(3) A rate-of-climb indicator (vertical speed).

(4) A gyroscopic rate-of-turn indicator combined with an integral slip-skid indicator (turn-and-bank indicator) except that only a slipskid indicator is required on large aeroplanes with a third attitude instrument system usable through flight attitudes of 360° of pitch and roll and installed in accordance with the applicable operating rules.

(5) A bank and pitch indicator (gyroscopically stabilised).

(6) A direction indicator (gyroscopically stabilised, magnetic or nonmagnetic).

(c) The following flight and navigation instruments are required as prescribed in this paragraph:

(1) A speed warning device is required for turbine engine powered aeroplanes and for aeroplanes with V_{MO}/M_{MO} greater than 0.8 V_{DF}/M_{DF} or 0.8 V_D/M_D. The speed warning device must give effective aural warning (differing distinctively from aural warnings used for other purposes) to the pilots, whenever the speed exceeds V_{MO} plus 6 knots or M_{MO} + 0.01. The upper limit of the production tolerance for the warning device may not exceed the prescribed warning speed.

(2) A machmeter is required at each pilot station for aeroplanes with compressibility limitations not otherwise indicated to the pilot by the airspeed indicating system required under paragraph (b)(1) of this section.

(Change 525-1 (87-01-01))

525.1305 *Powerplant Instruments*

The following are required powerplant instruments:

(a) For all aeroplanes.

(1) A fuel pressure warning means for each engine, or a master warning means for all engines with provision for isolating the individual warning means from the master warning means.

(2) A fuel quantity indicator for each fuel tank.

(3) An oil quantity indicator for each oil tank.

(4) An oil pressure indicator for each independent pressure oil system of each engine.

(5) An oil pressure warning means for each engine, or a master warning means for all engines with provision for isolating the individual warning means from the master warning means.

(6) An oil temperature indicator for each engine.

(7) Fire-warning devices that provide visual and audible warning.
(amended 2005/06/03)

(8) An augmentation liquid quantity indicator (appropriate for the manner in which the liquid is to be used in operation) for each tank.

(b) For reciprocating engine-powered aeroplanes. In addition to the powerplant instruments required by paragraph *(a)* of this section, the following powerplant instruments are required:

(1) A carburettor air temperature indicator for each engine.

(2) A cylinder head temperature indicator for each air-cooled engine.

(3) A manifold pressure indicator for each engine.

(4) A fuel pressure indicator (to indicate the pressure at which the fuel is supplied) for each engine.

(5) A fuel flowmeter, or fuel mixture indicator, for each engine without an automatic altitude mixture control.

(6) A tachometer for each engine.

(7) A device that indicates, to the flight crew (during flight), any change in the power output, for each engine with:

(i) An automatic propeller feathering system, whose operation is initiated by a power output measuring system; or

(ii) A total engine piston displacement of 2,000 cubic inches or more.

(8) A means to indicate to the pilot when the propeller is in reverse pitch, for each reversing propeller.

(c) For turbine engine-powered aeroplanes. In addition to the powerplant instruments required by paragraph *(a)* of this section, the following powerplant instruments are required:

(1) A gas temperature indicator for each engine.

(2) A fuel flowmeter indicator for each engine.

(3) A tachometer (to indicate the speed of the rotors with established limiting speeds) for each engine.

(4) A means to indicate, to the flight crew, the operation of each engine starter that can be operated continuously but that is neither designed for continuous operation nor designed to prevent hazard if it failed.

(5) An indicator to indicate the functioning of the powerplant ice protection system for each engine.

(6) An indicator for the fuel strainer or filter required by 525.997 to indicate the occurrence of contamination of the strainer or filter before it reaches the capacity established in accordance with 525.997(d).

(7) A warning means for the oil strainer or filter required by 525.1019, if it has no bypass, to warn the pilot of the occurrence of contamination of the strainer or filter screen before it reaches the capacity established in accordance with 525.1019(a)(2).

(8) An indicator to indicate the proper functioning of any heater used to prevent ice clogging of fuel system components.

(d) For turbojet engine-powered aeroplanes. In addition to the powerplant instruments required by *(a)* and *(c)* of this section, the following powerplant instruments are required:
(amended 2005/06/03)

(1) An indicator to indicate thrust, or a parameter that is directly related to thrust, to the pilot. The indication shall be based on the direct measurement of thrust or of parameters that are directly related to thrust. The indicator shall indicate a change in thrust resulting from any engine malfunction, damage, or deterioration.
(amended 2005/06/03)

(2) A position indicating means to indicate to the flight crew when the thrust reversing device:
(amended 2005/06/03)

(i) is not in the selected position, and
(amended 2005/06/03)

(ii) is in the reverse thrust position, for each engine using a thrust reversing device.
(amended 2005/06/03)

(3) An indicator to indicate rotor system unbalance.

(e) For turbopropeller-powered aeroplanes. In addition to the powerplant instruments required by paragraphs *(a)* and *(c)* of this section, the following powerplant instruments are required:

(1) A torque indicator for each engine.

(2) Position indicating means to indicate to the flight crew when the propeller blade angle is below the flight low pitch position, for each propeller.

(3) (Removed)

(f) For aeroplanes equipped with fluid systems (other than fuel) for thrust or power augmentation, an approved means shall be provided to indicate the proper functioning of that system to the flight crew.
(amended 2005/06/03)

(Change 525-6 (93-12-30))

525.1307 *Miscellaneous Equipment*

The following is required miscellaneous equipment:

(a) (Reserved)

(b) Two or more independent sources of electrical energy.

(c) Electrical protective devices, as prescribed in this chapter.

(d) Two systems for two-way radio communications, with controls for each accessible from each pilot station, designed and installed so that failure of one system will not preclude operation of the other system. The use of a common antenna system is acceptable if adequate reliability is shown.

(e) Two systems for radio navigation, with controls for each accessible from each pilot station, designed and installed so that failure of one system will not preclude operation of the other system. The use of a common antenna system is acceptable if adequate reliability is shown.

(f) (Removed)

(g) (Removed)

(h) (Removed)

(Change 525-3 (91-11-01))
(Change 525-4 (92-08-01))

525.1309 *Equipment, Systems, and Installations*

(a) The equipment, systems, and installations whose functioning is required by this manual, must be designed to ensure that they perform their intended functions under any foreseeable operating condition.

(b) The aeroplane systems and associated components, considered separately and in relation to other systems, must be designed so that:

(1) The occurrence of any failure condition which would prevent the continued safe flight and landing of the aeroplane is extremely improbable, and

(2) The occurrence of any other failure conditions which would reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions is improbable.

(c) Warning information must be provided to alert the crew to unsafe system operating conditions, and to enable them to take appropriate corrective action. Systems, controls, and associated monitoring and warning means must be designed to minimise crew errors which would create additional hazards.

(d) Compliance with the requirements of paragraph *(b)* of this section must be shown by analysis, and where necessary, by appropriate ground, flight, or simulator tests. The analysis must consider:

(1) Possible modes of failure, including malfunctions and damage from external sources.

(2) The probability of multiple failures and undetected failures.

(3) The resulting effects on the aeroplane and occupants, considering the stage of flight and operating conditions, and

(4) The crew warning cues, corrective action required, and the capability of detecting faults.

(e) In showing compliance with paragraphs *(a)* and *(b)* of this section with regard to the electrical system and equipment design and installation, critical environmental conditions must be considered. For electrical generation, distribution, and utilisation equipment required by or used in complying with this manual, except equipment covered by Technical Standard Orders containing environmental test procedures, the ability to provide continuous, safe service under foreseeable environmental conditions may be shown by environmental tests, design analysis, or reference to previous comparable service experience on other aircraft.

(f) EWIS must be assessed in accordance with the requirements of 525.1709.
(amended 2009/05/11)

525.1310 *Power Source Capacity and Distribution*
(amended 2009/05/11)

(a) Each installation whose functioning is required for type certification or under operating rules and that requires a power supply is an ''essential load'' on the power supply. The power sources and the system must be able to supply the following power loads in probable operating combinations and for probable durations:
(amended 2009/05/11)

(1) Loads connected to the system with the system functioning normally.
(amended 2009/05/11)

(2) Essential loads, after failure of any one prime mover, power converter, or energy storage device.
(amended 2009/05/11)

(3) Essential loads after failure of:
(amended 2009/05/11)

(i) Any one engine on two-engine aeroplanes; and
(amended 2009/05/11)

(ii) Any two engines on aeroplanes with three or more engines.
(amended 2009/05/11)

(4) Essential loads for which an alternate source of power is required, after any failure or malfunction in any one power supply system, distribution system, or other utilization system.
(amended 2009/05/11)

(b) In determining compliance with (a)(2) and (3) of this section, the power loads may be assumed to be reduced under a monitoring procedure consistent with safety in the kinds of operation authorized. Loads not required in controlled flight need not be considered for the two-engine-inoperative condition on aeroplanes with three or more engines.
(amended 2009/05/11)

525.1316 *System Lightning Protection*

(a) For functions whose failure would contribute to or cause a condition that would prevent the continued safe flight and landing of the aeroplane, each electrical and electronic system that performs these functions must be designed and installed to ensure that the operation and operational capabilities of the systems to perform these functions are not adversely affected when the aeroplane is exposed to lightning.

(b) For functions whose failure would contribute to or cause a condition that would reduce the capability of the aeroplane or the ability of the flight crew to cope with adverse operating conditions, each electrical and electronic system that performs these functions must be designed and installed to ensure that these functions can be recovered in a timely manner after the aeroplane is exposed to lightning.

(c) Compliance with the lightning protection criteria prescribed in paragraphs *(a)* and *(b)* of this section must be shown for exposure to a severe lightning environment. The applicant must design for and verify that aircraft electrical/electronic systems are protected against the effects of lightning by:

(1) Determining the lightning strike zones for the aeroplane;

(2) Establishing the external lightning environment for the zones;

(3) Establishing the internal environment;

(4) Identifying all the electrical and electronic systems that are subject to the requirements of this section, and their locations on or within the aeroplane;

(5) Establishing the susceptibility of the systems to the internal and external lightning environment;

(6) Designing protection; and

(7) Verifying that the protection is adequate.

(Change 525-7 (96-09-30))

525.1317 *High-intensity Radiated Fields (HIRF) Protection*
(amended 2008/10/30)

(a) Except as provided in paragraph (d) of this section, each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of

the aeroplane shall be designed and installed so that:
(amended 2008/10/30)

(1) The function is not adversely affected during and after the time the aeroplane is exposed to HIRF environment I, as described in Appendix L of this chapter;
(amended 2008/10/30)

(2) The system automatically recovers normal operation of that function, in a timely manner, after the aeroplane is exposed to HIRF environment I, as described in Appendix L of this chapter, unless the system's recovery conflicts with other operational or functional requirements of the system; and
(amended 2008/10/30)

(3) The system is not adversely affected during and after the time the aeroplane is exposed to HIRF environment II, as described in Appendix L of this chapter.
(amended 2008/10/30)

(b) Each electrical and electronic system that performs a function whose failure would significantly reduce the capability of the aeroplane or the ability of the flight-crew to respond to an adverse operating condition shall be designed and installed so the system is not adversely affected when the equipment providing these functions is exposed to equipment HIRF test level 1 or 2, as described in Appendix L of this chapter.
(amended 2008/10/30)

(c) Each electrical and electronic system that performs a function whose failure would reduce the capability of the aeroplane or the ability of the flight-crew to respond to an adverse operating condition shall be designed and installed so the system is not adversely affected when the equipment providing the function is exposed to equipment HIRF test level 3, as described in Appendix L of this chapter.
(amended 2008/10/30)

(d) Before December 1, 2012, an electrical or electronic system that performs a function whose failure would prevent the continued safe flight and landing of an aeroplane may be designed and installed without meeting the provisions of paragraph (a) provided:
(amended 2008/10/30)

(1) The system has previously been shown to comply with Special Conditions - Airworthiness for HIRF, specified by the Minister pursuant to Part V of the *Canadian Aviation Regulations* (CARs).
(amended 2008/10/30)

(2) The HIRF immunity characteristics of the system have not changed since compliance with the special conditions was demonstrated; and
(amended 2008/10/30)

(3) The data used to demonstrate compliance with the Special Conditions - Airworthiness is provided.
(amended 2008/10/30)

Instruments - Installation

525.1321 *Arrangement and Visibility*

(a) Each flight, navigation, and powerplant instrument for use by any pilot must be plainly visible to him from his station with the minimum practicable deviation from his normal position and line of vision when he is looking forward along the flight path.

(b) The flight instruments required by 525.1303 must be grouped on the instrument panel and centred as nearly as practicable about the vertical plane of the pilot's forward vision. In addition:

(1) The instrument that most effectively indicates attitude must be on the panel in the top centre position;

(2) The instrument that most effectively indicates airspeed must be adjacent to and directly to the left of the instrument in the top centre position;

(3) The instrument that most effectively indicates altitude must be adjacent to and directly to the right of the instrument in the top centre position; and

(4) The instrument that most effectively indicates direction of flight must be adjacent to and directly below the instrument in the top centre position.

(c) Required powerplant instruments must be closely grouped on the instrument panel. In addition:

(1) The location of identical powerplant instruments for the engines must prevent confusion as to which engine each instrument relates; and

(2) Powerplant instruments vital to the safe operation of the aeroplane must be plainly visible to the appropriate crew members.

(d) Instrument panel vibration may not damage or impair the accuracy of any instrument.

(e) If a visual indicator is provided to indicate malfunction of an instrument, it must be effective under all probable cockpit lighting conditions.

525.1322 *Flight Crew Alerting*
(amended 2012/03/27)

(a) Flight crew alerts must:
(amended 2012/03/27)

(1) Provide the flight crew with the information needed to:

(i) identify non-normal operation or aeroplane system conditions, and

(ii) determine the appropriate actions, if any.

(2) Be readily and easily detectable and intelligible by the flight crew under all foreseeable operating conditions, including conditions where multiple alerts are provided.

(3) Be removed when the alerting condition no longer exists.

(b) Alerts must conform to the following prioritization hierarchy based on the urgency of flight crew awareness and response.
(amended 2012/03/27)

(1) **Warning**: For conditions that require immediate flight crew awareness and immediate flight crew response.

(2) **Caution**: For conditions that require immediate flight crew awareness and subsequent flightcrew response.

(3) **Advisory**: For conditions that require flight crew awareness and may require subsequent flight crew response.

(c) Warning and caution alerts must:
(amended 2012/03/27)

(1) Be prioritized within each category, when necessary.

(2) Provide timely attention-getting cues through at least two different senses by a combination of aural, visual, or tactile indications.

(3) Permit each occurrence of the attention-getting cues required by paragraph (c)(2) of this section to be acknowledged and suppressed, unless they are required to be continuous.

(d) The alert function must be designed to minimise the effects of false and nuisance alerts. In particular, it must be designed to:
(amended 2012/03/27)

(1) Prevent the presentation of an alert that is inappropriate or unnecessary.

(2) Provide a means to suppress an attention-getting component of an alert caused by a failure of the alerting function that interferes with the flight crew's ability to safely operate the aeroplane. This means must not be readily available to the flight crew so that it could be operated inadvertently or by habitual reflexive action. When an alert is suppressed, there must be a clear and unmistakable annunciation to the flight crew that the alert has been suppressed.

(e) Visual alert indications must:
(amended 2012/03/27)

(1) Conform to the following colour convention:

(i) **Red** for warning alert indications.

(ii) **Amber or yellow** for caution alert indications.

(iii) Any colour except red or green for advisory alert indications.

(2) Use visual coding techniques, together with other alerting function elements on the flight deck, to distinguish between warning, caution, and advisory alert indications, if they are presented on monochromatic displays that are not capable of conforming to the colour convention in paragraph (e)(1) of this section.

(f) Use of the colours red, amber, and yellow on the flight deck for functions other than flight crew alerting must be limited and must not adversely affect flight crew alerting.
(amended 2012/03/27)

525.1323 *Airspeed Indicating System*

For each airspeed indicating system, the following apply:

(a) Each airspeed indicating instrument shall be approved and shall be calibrated to indicate true airspeed (at sea level with a standard atmosphere) with a minimum practicable instrument calibration error when the corresponding pitot and static pressures are applied.
(amended 2003/11/10)

(b) Each system shall be calibrated to determine the system error (that is, the relation between IAS and CAS) in flight and during the accelerated take-off ground run. The ground run calibration shall be determined:
(amended 2003/11/10)

(1) From 0.8 of the minimum value of V_1 to the maximum value of V_2, considering the approved ranges of altitude and weight; and

(2) With the flaps and power settings corresponding to the values determined in the establishment of the take-off path under 525.111 assuming that the critical engine fails at the minimum value of V_1.

(c) The airspeed error of the installation, excluding the airspeed indicator instrument calibration error, shall not exceed three percent or five knots, whichever is greater, throughout the speed range, from:
(amended 2003/11/10)

(1) V_{MO} to 1.23 V_{SR1} with flaps retracted; and
(amended 2003/11/10)

(2) 1.23 V_{SR0} to V_{FE} with flaps in the landing position.
(amended 2003/11/10)

(d) From 1.23 V_{SR} to the speed at which stall warning begins, the IAS shall change perceptibly with CAS and in the same sense, and at speeds below stall warning speed the IAS shall not change in an incorrect sense.
(amended 2003/11/10)

(e) From V_{MO} to V_{MO} + 2/3 ($V_{DF} - V_{MO}$), the IAS shall change perceptibly with CAS and in the same sense, and at higher speeds up to V_{DF} the IAS shall not change in an incorrect sense.
(amended 2003/11/10)

(f) There shall be no indication of airspeed that would cause undue difficulty to the pilot during the takeoff between the initiation of rotation and the achievement of a steady climbing condition.
(amended 2003/11/10)

(g) The effects of airspeed indicating system lag shall not introduce significant takeoff indicated airspeed bias, or significant errors in takeoff or accelerate-stop distances.
(amended 2003/11/10)

(h) Each system shall be arranged, so far as practicable, to prevent malfunction or serious error due to the entry of moisture, dirt, or other substances.
(amended 2003/11/10)

(i) Each system shall have a heated pitot tube or an equivalent means of preventing malfunction due to icing.
(amended 2003/11/10)

(j) Where duplicate airspeed indicators are required, their respective pitot tubes shall be far enough apart to avoid damage to both tubes in collision with a bird.
(amended 2003/11/10)

525.1325 *Static Pressure Systems*

(a) Each instrument with static air case connections must be vented to the outside atmosphere through an appropriate piping system.

(b) Each static port must be designed and located in such manner that the static pressure system performance is least affected by airflow variation, or by moisture or other foreign matter, and that the correlation between air pressure in the static pressure system and true ambient atmospheric static pressure is not changed when the aeroplane is exposed to the continuous and intermittent maximum icing conditions defined in Appendix C of this chapter.

(c) The design and installation of the static pressure system must be such that:

(1) Positive drainage of moisture is provided; chafing of the tubing and excessive distortion or restriction at bends in the tubing is avoided; and the materials used are durable, suitable for the purpose intended, and protected against corrosion; and

(2) It is airtight except for the port into the atmosphere. A proof test must be conducted to demonstrate the integrity of the static pressure system in the following manner:

(i) *Unpressurised aeroplanes.* Evacuate the static pressure system to a pressure differential of approximately 1 inch of mercury or to a reading on the altimeter, 1,000 feet above the aeroplane elevation at the time of the test. Without additional pumping for a period of 1 minute, the loss of indicated altitude must not exceed 100 feet on the altimeter.

(ii) *Pressurised aeroplanes.* Evacuate the static pressure system until a pressure differential equivalent to the maximum cabin pressure differential for which the aeroplane is type certificated is achieved. Without additional pumping for a period of 1 minute, the loss of indicated altitude must not exceed 2 percent of the equivalent altitude of the maximum cabin differential pressure or 100 feet, whichever is greater.

(d) Each pressure altimeter must be approved and must be calibrated to indicate pressure altitude in a standard atmosphere, with a minimum practicable calibration error when the corresponding static pressures are applied.

(e) Each system shall be designed and installed so that the error in indicated pressure altitude, at sea level, with a standard atmosphere, excluding instrument calibration error, does not result in an error of more than $\pm$30 feet per 100 knots speed for the appropriate configuration in the speed range between 1.23 V_{SR0} with flaps extended and 1.7 V_{SR1} with flaps retracted. However, the error need not be less than $\pm$30 feet.
(amended 2003/11/10)

(f) If an altimeter system is fitted with a device that provides corrections to the altimeter indication, the device must be designed and installed in such manner that it can be bypassed when it malfunctions, unless an alternate altimeter system is provided. Each correction device must be fitted with a means for indicating the occurrence of reasonably probable malfunctions, including power failure, to the flight crew. The indicating means must be effective for any cockpit lighting condition likely to occur.

(g) Except as provided in paragraph *(h)* of this section, if the static pressure system incorporates both a primary and an alternate static pressure source, the means for selecting one or the other source must be designed so that:

(1) When either source is selected, the other is blocked off; and

(2) Both sources cannot be blocked off simultaneously.

(h) For unpressurised aeroplanes, paragraph *(g)*(1) of this section does not apply if it can be demonstrated that the static pressure system calibration, when either static pressure source is selected, is not changed by the other static pressure source being open or blocked.

525.1326 *Pitot Heat Indication Systems*

If a flight instrument pitot heating system is installed, an indication system must be provided to indicate to the flight crew when that pitot heating system is not operating. The indication system must comply with the following requirements:

(a) The indication provided must incorporate an amber light that is in clear view of a flight crew member.

(b) The indication provided must be designed to alert the flight crew if either of the following conditions exist:

(1) The pitot heating system is switched "off".

(2) The pitot heating system is switched "on" and any pitot tube heating element is inoperative.

525.1327 *Magnetic Direction Indicator*

(a) Each magnetic direction indicator must be installed so that its accuracy is not excessively affected by the aeroplane's vibration or magnetic fields.

(b) The compensated installation may not have a deviation, in level flight, greater than 10° on any heading.

525.1329 *Flight Guidance System*
(amended 2007/07/16)

(a) Quick disengagement controls for the autopilot and autothrust functions shall be provided for each pilot. The autopilot quick disengagement controls shall be located on both control wheels (or equivalent). The autothrust quick disengagement controls shall be located on the thrust control levers. Quick disengagement controls shall be readily accessible to each pilot while operating the control wheel (or equivalent) and thrust control levers.
(amended 2007/07/16)

(b) The effects of a failure of the system to disengage the autopilot or autothrust functions when manually commanded by the pilot shall be assessed in accordance with the requirements of section 525.1309.
(amended 2007/07/16)

(c) Engagement or switching of the flight guidance system, a mode, or a sensor may not cause a transient response of the aeroplane's flight path any greater than a minor transient, as defined in paragraph (n)(1) of this section.
(amended 2007/07/16)

(d) Under normal conditions, the disengagement of any automatic control function of a flight guidance system may not cause a transient response of the aeroplane's flight path any greater than a minor transient.
(amended 2007/07/16)

(e) Under rare normal and non-normal conditions, disengagement of any automatic control function of a flight guidance system shall not result in a transient any greater than a significant transient, as defined in paragraph (n)(2) of this section.
(amended 2007/07/16)

(f) The function and direction of motion of each command reference control, such as heading select or vertical speed, shall be plainly indicated on, or adjacent to, each control if necessary to prevent inappropriate use or confusion.
(amended 2007/07/16)

(g) Under any condition of flight appropriate to its use, the flight guidance system may not produce hazardous loads on the aeroplane, nor create hazardous deviations in the flight path. This applies to both fault-free operation and in the event of a malfunction, and assumes that the pilot begins corrective action within a reasonable period of time.
(amended 2007/07/16)

(h) When the flight guidance system is in use, a means shall be provided to avoid excursions beyond an acceptable margin from the speed range of the normal flight envelope. If the aeroplane experiences an excursion outside this range, a means shall be provided to prevent the flight guidance system from providing guidance or control to an unsafe speed.
(amended 2007/07/16)

(i) The flight guidance system functions, controls, indications, and alerts shall be designed to minimize flight crew errors and confusion concerning the behaviour and operation of the flight guidance system. Means shall be provided to indicate the current mode of operation, including any armed modes, transitions, and reversions. Selector switch position is not an acceptable means of indication. The controls and indications shall be grouped and presented in a logical and consistent manner. The indications shall be visible to each pilot under all expected lighting conditions.
(amended 2007/07/16)

(j) Following disengagement of the autopilot, a warning (visual and auditory) shall be provided to each pilot and be timely and distinct from all other cockpit warnings.
(amended 2007/07/16)

(k) Following disengagement of the autothrust function, a caution shall be provided to each pilot.
(amended 2007/07/16)

(l) The autopilot shall not create a potential hazard when the flightcrew applies an override force to the flight controls.
(amended 2007/07/16)

(m) During autothrust operation, it shall be possible for the flightcrew to move the thrust levers without requiring excessive force. The autothrust shall not create a potential hazard when the flightcrew applies an override force to the thrust levers.
(amended 2007/07/16)

(n) For purposes of this section, a transient is a disturbance in the control or flight path of the aeroplane that is not consistent with response to flightcrew inputs or environmental conditions.
(amended 2007/07/16)

(1) A minor transient would not significantly reduce safety margins and would involve flight crew actions that are well within their capabilities. A minor transient may involve a slight increase in flightcrew workload or some physical discomfort to passengers or cabin crew.

(2) A significant transient may lead to a significant reduction in safety margins, an increase in flight crew workload, discomfort to the flight crew, or physical distress to the passengers or cabin crew, possibly including non-fatal injuries. Significant transients do not require, in order to remain within or recover to the normal flight envelope, any of the following:

(i) exceptional piloting skill, alertness, or strength;

(ii) forces applied by the pilot which are greater than those specified in 525.143(c); and

(iii) accelerations or attitudes in the aeroplane that might result in further hazard to secured or non-secured occupants.

525.1331 *Instruments Using a Power Supply*

(a) For each instrument required by 525.1303*(b)* that uses a power supply, the following apply:

(1) Each instrument must have a visual means integral with the instrument, to indicate when power adequate to sustain proper instrument performance is not being supplied. The power must be measured at or near the point where it enters the instruments. For electric instruments, the power is considered to be adequate when the voltage is within approved limits.

(2) Each instrument must, in the event of the failure of one power source, be supplied by another power source. This may be accomplished automatically or by manual means.

(3) If an instrument presenting navigation data receives information from sources external to that instrument and loss of that information would render the presented data unreliable,

the instrument must incorporate a visual means to warn the crew, when such loss of information occurs, that the presented data should not be relied upon.

(b) As used in this section, "instrument" includes devices that are physically contained in one unit, and devices that are composed of two or more physically separate units or components connected together (such as a remote indicating gyroscopic direction indicator that includes a magnetic sensing element, a gyroscopic unit, an amplifier, and an indicator connected together).

525.1333 *Instrument Systems*

For systems that operate the instruments required by 525.1303(b) which are located at each pilot's station:

(a) Means must be provided to connect the required instruments at the first pilot's station to operating systems which are independent of the operating systems at other flight crew stations, or other equipment;

(b) The equipment, systems, and installations must be designed so that one display of the information essential to the safety of flight which is provided by the instruments, including attitude, direction, airspeed, and altitude will remain available to the pilots, without additional crew member action, after any single failure or combination of failures that is not shown to be extremely improbable; and

(c) Additional instruments systems, or equipment may not be connected to the operating systems for the required instruments, unless provisions are made to ensure the continued normal functioning of the required instruments in the event of any malfunction of the additional instruments, systems, or equipment which is not shown to be extremely improbable.

525.1335 *[Removed]*

(amended 2007/07/16)

525.1337 *Powerplant Instruments*

(a) Instruments and instrument lines.

(1) Each powerplant and auxiliary power unit instrument line must meet the requirements of 525.993 and 525.1183.

(2) Each line carrying flammable fluids under pressure must:

(i) Have restricting orifices or other safety devices at the source of pressure to prevent the escape of excessive fluid if the line fails; and

(ii) Be installed and located so that the escape of fluids would not create a hazard.

(3) Each powerplant and auxiliary power unit instrument that utilises flammable fluids must be installed and located so that the escape of fluid would not create a hazard.

(b) Fuel quantity indicator. There must be means to indicate to the flight crewmembers, the quantity, in gallons or equivalent units, of usable fuel in each tank during flight. In addition:

(1) Each fuel quantity indicator must be calibrated to read "zero" during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply determined under 525.959.

(2) Tanks with interconnected outlets and airspaces may be treated as one tank and need not have separate indicators; and

(3) Each exposed sight gauge, used as a fuel quantity indicator, must be protected against damage.

(c) Fuel flowmeter system. If a fuel flowmeter system is installed, each metering component must have a means for bypassing the fuel supply if malfunction of that component severely restricts fuel flow.

(d) Oil quantity indicator. There must be a stick gauge or equivalent means to indicate the quantity of oil in each tank. If an oil transfer or reserve oil supply system is installed, there must be a means to indicate to the flight crew, in flight, the quantity of oil in each tank.

(e) Turbopropeller blade position indicator. Required turbopropeller blade position indicators must begin indicating before the blade moves more than eight degrees below the flight low pitch stop. The source of indication must directly sense the blade position.

(f) Fuel pressure indicator. There must be means to measure fuel pressure, in each system supplying reciprocating engines, at a point downstream of any fuel pump except fuel injection pumps. In addition:

(1) If necessary for the maintenance of proper fuel delivery pressure, there must be a connection to transmit the carburettor air intake static pressure to the proper pump relief valve connection; and

(2) If a connection is required under subparagraph (1) of this paragraph, the gauge balance lines must be independently connected to the carburettor inlet pressure to avoid erroneous readings.

Electrical Systems and Equipment

525.1351 *General*

(a) Electrical system capacity. The required generating capacity, and number and kinds of power sources must:

(1) Be determine by an electrical load analysis; and

(2) Meet the requirements of 525.1309.

(b) Generating system. The generating system includes electrical power sources, main power busses, transmission cables, and associated control, regulation, and protective devices. It must be designed so that:

(1) Power sources function properly when independent and when connected in combination;

(2) No failure or malfunction of any power source can create a hazard or impair the ability of remaining sources to supply essential loads;

(3) The system voltage and frequency (as applicable) at the terminals of all essential load equipment can be maintained within the limits for which the equipment is designed, during any probable operating condition; and

(4) System transients due to switching, fault clearing, or other causes do not make essential loads inoperative, and do not cause a smoke or fire hazard.

(5) There are means accessible, in flight, to appropriate crewmembers for the individual and collective disconnection of the electrical power sources from the system.

(6) There are means to indicate to appropriate crewmembers the generating system quantities essential for the safe operation of the system, such as the voltage and current supplied by each generator.

(c) External power. If provisions are made for connecting external power to the aeroplane, and that external power can be electrically connected to equipment other than that used for engine starting, means must be provided to ensure that no external power supply having a reverse polarity or a reverse phase sequence, can supply power to the aeroplane's electrical system.

(d) Operation without normal electrical power. It must be shown by analysis, tests, or both, that the aeroplane can be operated safely in VFR conditions, for a period of not less than five minutes, with the normal electrical power (electrical power sources excluding the battery) inoperative, with critical type fuel (from the standpoint of flameout and restart capability), and with the aeroplane initially at the maximum certificated altitude. Parts of the electrical system may remain on if:

(1) A single malfunction, including a wire bundle or junction box fire, cannot result in loss of both the part turned off and the part turned on; and

(2) The parts turned on are electrically and mechanically isolated from the parts turned off.

(Change 525-3 (91-11-01))

525.1353 *Electrical Equipment and Installations*

(a) Electrical equipment and controls must be installed so that operation of any one unit or system of units will not adversely affect the simultaneous operation of any other electrical unit or system essential to the safe operation. Any electrical interference likely to be present in the aeroplane must not result in hazardous effects on the aeroplane or its systems.
(amended 2009/05/11)

(b) Storage batteries must be designed and installed as follows:

(1) Safe cell temperatures and pressures must be maintained during any probable charging or discharging condition. No uncontrolled increase in cell temperature may result when the battery is recharged (after previous complete discharge):

(i) At maximum regulated voltage or power;

(ii) During a flight of maximum duration; and

(iii) Under the most adverse cooling condition likely to occur in service.

(2) Compliance with (b)(1) of this section must be shown by test unless experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures presents no problem.
(amended 2009/05/11)

(3) No explosive or toxic gases emitted by any battery in normal operation, or as the result of any probable malfunction in the charging system or battery installation, must accumulate in hazardous quantities within the aeroplane.
(amended 2009/05/11)

(4) No corrosive fluids or gases that may escape from the battery must damage surrounding aeroplane structures or adjacent essential equipment.
(amended 2009/05/11)

(5) Each nickel cadmium battery installation must have provisions to prevent any hazardous effect on structure or essential systems that may be caused by the maximum amount of heat the battery can generate during a short circuit of the battery or of individual cells.
(amended 2009/05/11)

(6) Nickel cadmium battery installations must have:
(amended 2009/05/11)

(i) A system to control the charging rate of the battery automatically so as to prevent battery overheating;

(ii) A battery temperature sensing and over-temperature warning system with a means for disconnecting the battery from its charging source in the event of an over-temperature condition; or

(iii) A battery failure sensing and warning system with a means for disconnecting the battery from its charging source in the event of battery failure.

(c) Electrical bonding must provide an adequate electrical return path under both normal and fault conditions, on aeroplanes having grounded electrical systems.
(amended 2009/05/11)

525.1355 *Distribution System*

(a) The distribution system includes the distribution busses, their associated feeders, and each control and protective device.

(b) (Reserved)

(c) If two independent sources of electrical power for particular equipment or systems are required by this manual, in the event of the failure of one power source for such equipment or system, another power source (including its separate feeder) must be automatically provided or be manually selectable to maintain equipment or system operation.

525.1357 *Circuit Protective Devices*

(a) Automatic protective devices must be used to minimise distress to the electrical system and hazard to the aeroplane in the event of wiring faults or serious malfunction of the system or connected equipment.

(b) The protective and control devices in the generating system must be designed to de-energise and disconnect faulty power sources and power transmission equipment from their associated busses with sufficient rapidity to provide protection from hazardous over-voltage and other malfunctioning.

(c) Each re-settable circuit protective device must be designed so that, when an overload or circuit fault exists, it will open the circuit irrespective of the position of the operating control.

(d) If the ability to reset a circuit breaker or replace a fuse is essential to safety in flight, that circuit breaker or fuse must be located and identified so that it can be readily reset or replaced in flight. Where fuses are used, there must be spare fuses for use in flight equal to at least 50% of the number of fuses of each rating required for complete circuit protection.
(amended 2009/05/11)

(e) Each circuit for essential loads must have individual circuit protection. However, individual protection for each circuit in an essential load system (such as each position light circuit in a system) is not required.

(f) For aeroplane systems for which the ability to remove or reset power during normal operations is necessary, the system must be designed so that circuit breakers are not the primary means to remove or reset system power unless specifically designed for use as a switch.
(amended 2009/05/11)

(g) Automatic reset circuit breakers may be used as integral protectors for electrical equipment (such as thermal cut-outs) if there is circuit protection to protect the cable to the equipment.

525.1359 *(Removed)*

(Change 525-3 (91-11-01))

525.1360 *Precautions Against Injury*

(amended 2009/05/11)

(a) Shock. The electrical system must be designed to minimize risk of electric shock to crew, passengers and servicing personnel and to maintenance personnel using normal precautions.
(amended 2009/05/11)

(b) Burns. The temperature of any part that may be handled by a crew member during normal operations must not cause dangerous inadvertent movement by the crew member or injury to the crew member.
(amended 2009/05/11)

525.1362 *Electrical Supplies for Emergency Conditions*

(amended 2009/05/11)

A suitable electrical supply must be provided to those services required for emergency procedures after an emergency landing or ditching. The circuits for these services must be designed, protected, and installed so that the risk of the services being rendered ineffective under these emergency conditions is minimized.
(amended 2009/05/11)

525.1363 *Electrical System Tests*

(a) When laboratory tests of the electrical system are conducted:

(1) The tests must be performed on a mock-up using the same generating equipment used in the aeroplane;

(2) The equipment must simulate the electrical characteristics of the distribution wiring and connected loads to the extent necessary for valid test results; and

(3) Laboratory generator drives must simulate the actual prime movers on the aeroplane with respect to their reaction to generator loading, including loading due to faults.

(b) For each flight condition that cannot be simulated adequately in the laboratory or by ground tests on the aeroplane, flight tests must be made.

525.1365 *Electrical Appliances, Motors, and Transformers*
(amended 2009/05/11)

(a) Domestic appliances must be designed and installed so that in the event of failures of the electrical supply or control system, the requirements of 525.1309(b), (c), and (d) will be satisfied. Domestic appliances are items such as cooktops, ovens, coffee makers, water heaters, refrigerators, and toilet flush systems that are placed on the aeroplane to provide service amenities to passengers.
(amended 2009/05/11)

(b) Galleys and cooking appliances must be installed in a way that minimizes risk of overheat or fire.
(amended 2009/05/11)

(c) Domestic appliances, particularly those in galley areas, must be installed or protected so as to prevent damage or contamination of other equipment or systems from fluids or vapours which may be present during normal operation or as a result of spillage, if such damage or contamination could create a hazardous condition.
(amended 2009/05/11)

(d) Unless compliance with 525.1309(b) is provided by the circuit protective device required by 525.1357(a), electric motors and transformers, including those installed in domestic systems, must have a suitable thermal protection device to prevent overheating under normal operation and failure conditions, if overheating could create a smoke or fire hazard.
(amended 2009/05/11)

Lights

525.1381 *Instrument Lights*

(a) The instrument lights must:

(1) Provide sufficient illumination to make each instrument, switch and other device necessary for safe operation easily readable unless sufficient illumination is available from another source; and

(2) Be installed so that:

(i) Their direct rays are shielded from the pilot's eyes; and

(ii) No objectionable reflections are visible to the pilot.

(b) Unless undimmed instrument lights are satisfactory under each expected flight condition, there must be a means to control the intensity of illumination.

(Change 525-3 (91-11-01))

525.1383 *Landing Lights*

(a) Each landing light must be approved, and must be installed so that:

(1) No objectionable glare is visible to the pilot;

(2) The pilot is not adversely affected by halation; and

(3) It provides enough light for night landing.

(b) Except when one switch is used for the lights of a multiple light installation at one location, there must be a separate switch for each light.

(c) There must be a means to indicate to the pilots when the landing lights are extended.

525.1385 *Position Light System Installation*

(a) General. Each part of each position light system must meet the applicable requirements of this section and each system as a whole must meet the requirements of 525.1387 through 525.1397.

(b) Forward position lights. Forward position lights must consist of a red and a green light spaced laterally as far apart as practicable and installed forward on the aeroplane so that, with the aeroplane in the normal flying position, the red light is on the left side, and the green light is on the right side. Each light must be approved.

(c) Rear position light. The rear position light must be a white light mounted as far aft as practicable on the tail or on each wing tip, and must be approved.

(d) Light covers and colour filters. Each light cover or colour filter must be at least flame resistant and may not change colour or shape or lose any appreciable light transmission during normal use.

525.1387 *Position Light System Dihedral Angles*

(a) Except as provided in paragraph *(e)* of this section, each forward and rear position light must, as installed, show unbroken light within the dihedral angles described in this section.

(b) Dihedral angle L (left) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the aeroplane, and the other at 110 degrees to the left of the first, as viewed when looking forward along the longitudinal axis.

(c) Dihedral angle R (right) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the aeroplane, and the other at 110 degrees to the right of the first, as viewed when looking forward along the longitudinal axis.

(d) Dihedral angle A (aft) is formed by two intersecting vertical planes making angles of 70 degrees to the right and to the left, respectively, to a vertical plane passing through the longitudinal axis, as viewed when looking aft along the longitudinal axis.

(e) If the rear position light, when mounted as far aft as practicable in accordance with 525.1385*(c)*, cannot show unbroken light with dihedral angle A (as defined in paragraph *(d)* of

this section), a solid angle or angles of obstructed visibility totalling not more than 0.04 steradians is allowable within that dihedral angle, if such solid angle is within a cone whose apex is at the rear position light and whose elements make an angle of 30° with a vertical line passing through the rear position light.

525.1389 *Position Light Distribution and Intensities*

(a) General. The intensities prescribed in this section must be provided by new equipment with light covers and colour filters in place. Intensities must be determined with the light source operating at a steady value equal to the average luminous output of the source at the normal operating voltage of the aeroplane. The light distribution and intensity of each position light must meet the requirements of paragraph *(b)* of this section.

(b) Forward and rear position lights. The light distribution and intensities of forward and rear position lights must be expressed in terms of minimum intensities in the horizontal plane, minimum intensities in any vertical plane, and maximum intensities in overlapping beams, within dihedral angles L, R, and A, and must meet the following requirements:

(1) *Intensities in the horizontal plane.* Each intensity in the horizontal plane (the plane containing the longitudinal axis of the aeroplane and perpendicular to the plane of symmetry of the aeroplane) must equal or exceed the values in 525.1391.

(2) *Intensities in any vertical plane.* Each intensity in any vertical plane (the plane perpendicular to the horizontal plane) must equal or exceed the appropriate value in 525.1393, where *I* is the minimum intensity prescribed in 525.1391 for the corresponding angles in the horizontal plane.

(3) *Intensities in overlaps between adjacent signals.* No intensity in any overlap between adjacent signals may exceed the values given in 525.1395, except that higher intensities in overlaps may be used with main beam intensities substantially greater than the minima specified in 525.1391 and 525.1393 if the overlap intensities in relation to the main beam intensities do not adversely affect signal clarity. When the peak intensity of the forward position lights is more than 100 candles, the maximum overlap intensities between them may exceed the values given in 525.1395 if the overlap intensity in Area A is not more than 10 percent of peak position light intensity and the overlap intensity in Area B is not greater than 2.5 percent of peak position light intensity.

525.1391 *Minimum Intensities in the Horizontal Plane of Forward and Rear Position Lights*

Each position light intensity must equal or exceed the applicable values in the following table:

Dihedral Angle (light included)	Angle from right or left of longitudinal axis, measured from dead ahead	Intensity (candles)
L and R (forward red and green)	0° to 10°	40
	10° to 20°	30

Dihedral Angle (light included)	Angle from right or left of longitudinal axis, measured from dead ahead	Intensity (candles)
	20° to 110°	5
A (rear white)	110° to 180°	20

525.1393 *Minimum Intensities in Any Vertical Plane of Forward and Rear Position Lights*

Each position light intensity must equal or exceed the applicable values in the following table:

Angle above or below the horizontal plane:	Intensity, *I*
0°	1.00
0° to 5°	0.90
5° to 10°	0.80
10° to 15°	0.70
15° to 20°	0.50
20° to 30°	0.30
30° to 40°	0.10
40° to 90°	0.05

525.1395 *Maximum Intensities in Overlapping Beams of Forward and Rear Position Lights*

No position light intensity may exceed the applicable values in the following table, except as provided in 525.1389(b)(3).

Overlaps	Maximum Intensity	
	Area A (candles)	Area B (candles)
Green in dihedral angle L	10	1
Red in dihedral angle R	10	1
Green in dihedral angle A	5	1
Red in dihedral angle A	5	1
Rear white in dihedral angle L	5	1
Rear white in dihedral angle R	5	1

Where:

(a) Area A includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 10 degrees but less than 20 degrees; and.

(b) Area B includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 20 degrees.

525.1397 *Colour Specifications*

Each position light colour must have the applicable International Commission on Illumination chromaticity co-ordinates as follows:

(a) Aviation red:

"y" is not greater than 0.335; and

"z" is not greater than 0.002.

(b) Aviation green:

"x" is not greater than 0.440-0.320y;

"x" is not greater than y-0.170; and

"y" is not less than 0.390-0.170x.

(c) Aviation white:

"x" is not less than 0.300 and not greater than 0.540;

"y" is not less than "x"-0.040" or "y_0-0.010", whichever is the smaller; and

"y" is not greater than "x + 0.020" nor "0.636-0.400x";

Where "y_0" is the "y" co-ordinate of the Planckian radiator for the value of "x" considered.

525.1399 *Riding Light*

(a) Each riding (anchor) light required for a seaplane or amphibian must be installed so that it can:

(1) Show a white light for at least two nautical miles at night under clear atmospheric conditions; and

(2) Show the maximum unbroken light practicable when the aeroplane is moored or drifting on the water.

(b) Externally hung lights may be used.

525.1401 *Anticollision Light System*

(a) General. The aeroplane must have an anticollision light system that:

(1) Consists of one or more approved anticollision lights located so that their light will not impair the crew's vision or detract from the conspicuity of the position lights; and

(2) Meets the requirements of paragraphs (b) through (f) of this section.

(b) Field of coverage. The system must consist of enough lights to illuminate the vital areas around the aeroplane considering the physical configuration and flight characteristics of the

aeroplane. The field of coverage must extend in each direction within at least 75° above and 75° below the horizontal plane of the aeroplane, except that a solid angle or angles of obstructed visibility totalling not more than 0.03 steradians is allowable within a solid angle equal to 0.15 steradians centred about the longitudinal axis in the rearward direction.

(c) Flashing characteristics. The arrangement of the system, that is, the number of light sources, beam width, speed of rotation, and other characteristics, must give an effective flash frequency of not less than 40, nor more than 100, cycles per minute. The effective flash frequency is the frequency at which the aeroplane's complete anti-collision light system is observed from a distance, and applies to each sector of light including any overlaps that exist when the system consists of more than one light source. In overlaps, flash frequencies may exceed 100, but not 180, cycles per minute.

(d) Colour. Each anticollision light must be either aviation red or aviation white and must meet the applicable requirements of 525.1397.

(e) Light intensity. The minimum light intensities in all vertical planes, measured with the red filter (if used) and expressed in terms of "effective" intensities, must meet the requirements of paragraph *(f)* of this section. The following relation must be assumed:

$$I_e = \frac{\int_{t2}^{t1} I(t)dt}{0.2 + (t_2 - t_1)}$$

where:

I_e = effective intensity (candles).

$I(t)$ = instantaneous intensity as a function of time.

$t_2 - t_1$ = flash time interval (seconds).

Normally, the maximum value of effective intensity is obtained when t_2 and t_1 are chosen so that the effective intensity is equal to the instantaneous intensity at t_2 and t_1.

(f) Minimum effective intensities for anticollision lights. Each anticollision light effective intensity must equal or exceed the applicable values in the following table:

Angle above or below the horizontal plane	**Effective Intensity (candles)**
0° to 5°	400
5° to 10°	240
10° to 20°	80
20° to 30°	40
30° to 75°	20

525.1403 *Wing Icing Detection Lights*

Unless operations at night in known or forecast icing conditions are prohibited by an operating limitation, a means must be provided for illuminating or otherwise determining the

formation of ice on the parts of the wings that are critical from the standpoint of ice accumulation. Any illumination that is used must be of a type that will not cause glare or reflection that would handicap crew members in the performance of their duties.

Safety Equipment

525.1411 *General*

(a) Accessibility. Required safety equipment to be used by the crew in an emergency must be readily accessible.

(b) Stowage provisions. Stowage provisions for required emergency equipment must be furnished and must:

(1) Be arranged so that the equipment is directly accessible and its location is obvious; and

(2) Protect the safety equipment from inadvertent damage.

(c) Emergency exit descent device. The stowage provisions for the emergency exit descent device required by 525.810*(a)* shall be at the exit for which they are intended.
(amended 2007/03/08)

(d) Liferafts.

(1) The stowage provisions for the liferafts described in 525.1415 must accommodate enough rafts for the maximum number of occupants for which certification for ditching is requested.

(2) Liferafts must be stowed near exits through which the rafts can be launched during an unplanned ditching.

(3) Rafts automatically or remotely released outside the aeroplane must be attached to the aeroplane by means of the static line prescribed in 525.1415.

(4) The stowage provisions for each portable liferaft must allow rapid detachment and removal of the raft for use at other than the intended exits.

(e) Long-range signalling device. The stowage provisions for the long-range signalling device required by 525.1415 must be near an exit available during an unplanned ditching.

(f) Life preserver stowage provisions. The stowage provisions for life preservers described in 525.1415 must accommodate one life preserver for each occupant for which certification for ditching is requested. Each life preserver must be within easy reach of each seated occupant.

(g) Life line stowage provisions. If certification for ditching under 525.801 is requested, there must be provisions to store life lines. These provisions must:

(1) Allow one life line to be attached to each side of the fuselage; and

(2) Be arranged to allow the life lines to be used to enable the occupants to stay on the wing after ditching.

(Change 525-6 (93-12-30))

525.1413 *(Removed)*

(Change 525-3 (91-11-01))

525.1415 *Ditching Equipment*

(a) Ditching equipment used in aeroplanes to be certificated for ditching under 525.801, and required by the applicable operating rules, must meet the requirements of this section.

(b) Each liferaft and each life preserver must be approved. In addition:

(1) Unless excess rafts of enough capacity are provided, the buoyancy and seating capacity beyond the rated capacity of the rafts must accommodate all occupants of the aeroplane in the event of a loss of one raft of the largest rated capacity; and

(2) Each raft must have a trailing line, and must have a static line designed to hold the raft near the aeroplane but to release it if the aeroplane becomes totally submerged.

(c) Approved survival equipment must be attached to each liferaft.

(d) There must be an approved survival type emergency locator transmitter for use in one life raft.

(e) For aeroplanes not certificated for ditching under 525.801 and not having approved life preservers, there must be an approved flotation means for each occupant. This means must be within easy reach of each seated occupant and must be readily removable from the aeroplane.

(Change 525-3 (91-11-01))
(Change 525-7 (96-09-30))

525.1416 *(Removed)*

(Change 525-3 (91-11-01))

525.1419 *Ice Protection*

If the applicant seeks certification for flight in icing conditions, the aeroplane shall be able to safely operate in the continuous maximum and intermittent maximum icing conditions of Appendix C. To establish this:
(amended 2008/10/30)

(a) An analysis must be performed to establish that the ice protection for the various components of the aeroplane is adequate, taking into account the various aeroplane operational configurations; and

(b) To verify the ice protection analysis, to check for icing anomalies, and to demonstrate that the ice protection system and its components are effective, the aeroplane or its components must be flight tested in the various operational configurations, in measured natural atmospheric icing conditions and, as found necessary, by one or more of the following means:

(1) Laboratory dry air or simulated icing tests, or a combination of both, of the components or models of the components.

(2) Flight dry air tests of the ice protection system as a whole, or of its individual components.

(3) Flight tests of the aeroplane or its components in measured simulated icing conditions.

(c) Caution information, such as an amber caution light or equivalent, must be provided to alert the flight crew when the anti-ice or de-ice system is not functioning normally.

(d) For turbine engine powered aeroplanes, the ice protection provisions of this section are considered to be applicable primarily to the airframe. For the power plant installation, certain additional provisions of Subchapter E of this chapter may be found applicable.

(Change 525-3 (91-11-01))

525.1421 *Megaphones*

If a megaphone is installed, a restraining means must be provided that is capable of restraining the megaphone when it is subjected to the ultimate inertia forces specified in 525.561(b)(3).

525.1423 *Public Address System*

A public address system required by the CARs shall:
(amended 2005/06/03)

(a) Be powerable, when the aircraft is in flight or stopped on the ground, after the shutdown or failure of all engines and auxiliary power units, or the disconnection or failure of all power sources dependent on their continued operation, for :

(1) A time duration of a least 10 minutes, including an aggregate time duration of at least 5 minutes of announcements made by flight and cabin crew members, considering all other loads which may remain powered by the same source when all other power sources are inoperative; and
(amended 2005/06/03)

(2) An additional time duration in its standby state appropriate or required for any other loads that are powered by the same source and that are essential to safety of flight or required during emergency conditions.

(b) Be capable of operation within 3 seconds from the time a microphone is removed from its stowage.
(amended 2005/06/03)

(c) Be intelligible at all passenger seats, lavatories, and flight attendant seats and work stations.

(d) Be designed so that no unused, unstowed microphone will render the system inoperative.

(e) Be capable of functioning independently of any required crewmember interphone system.

(f) Be accessible for immediate use from each of two flight crewmember stations in the pilot compartment.

(g) For each required floor-level passenger emergency exit which has an adjacent flight attendant seat, have a microphone which is readily accessible to the seated flight attendant, except that one microphone may serve more than one exit, provided the proximity of the exits allows unassisted verbal communication between seated flight attendants.

(Change 525-3 (91-11-01))
(Change 525-6 (93-12-30))

Miscellaneous Equipment

525.1431 *Electronic Equipment*

(a) In showing compliance with 525.1309*(a)* and *(b)* with respect to radio and electronic equipment and their installations, critical environmental conditions must be considered.

(b) Radio and electronic equipment must be supplied with power under the requirements of 525.1355*(c)*.

(c) Radio and electronic equipment, controls, and wiring must be installed so that operation of any one unit or system of units will not adversely affect the simultaneous operation of any other radio or electronic unit, or system of units, required by this manual.

(d) Electronic equipment shall be designed and installed such that it does not cause essential loads to become inoperative as a result of electrical power supply transients or transients from other causes.
(amended 2004/07/16)

525.1433 *Vacuum Systems*

There must be means, in addition to the normal pressure relief, to automatically relieve the pressure in the discharge lines from the vacuum air pump when the delivery temperature of the air becomes unsafe.

525.1435 *Hydraulic Systems*

(a) Element Design. Each element of the hydraulic system shall be designed to:
(amended 2001/10/24)

(1) withstand the proof pressure without permanent deformation that would prevent it from performing its intended functions, and the ultimate pressure without rupture. The proof and ultimate pressures are defined in terms of the design operating pressure (DOP) as follows:
(amended 2001/10/24)

Element	Proof (xDOP)	Ultimate (xDOP)
1. Tubes and fittings	1.5	3.0
2. Pressure vessels containing gas: High pressure (e.g. accumulators) Low pressure (e.g. reservoirs)	 3.0 1.5	 4.0 3.0
3. Hoses	2.0	4.0
4. All other elements	1.5	2.0

(2) withstand, without deformation that would prevent it from performing its intended function, the design operating pressure in combination with limit structural loads that may be imposed;
(amended 2001/10/24)

(3) withstand, without rupture, the design operating pressure multiplied by a factor of 1.5 in combination with ultimate structural load that can reasonably occur simultaneously;
(amended 2001/10/24)

(4) withstand the fatigue effects of all cyclic pressures, including transient, and associated externally induced loads, taking into account the consequences of element failure; and
(amended 2001/10/24)

(5) perform as intended under all environmental conditions for which the aeroplane is certified.
(amended 2001/10/24)

(b) System design. Each hydraulic system shall:
(amended 2001/10/24)

(1) have means located at a flight crew station to indicate appropriate system parameters, if
(amended 2001/10/24)

(i) it performs a function necessary for continued safe flight and landing; or

(ii) in the event of hydraulic system malfunction, corrective action by the crew to ensure continued safe flight and landing is necessary;

(2) have means to ensure that system pressures, including transient pressures and pressures from fluid volumetric changes in elements that are likely to remain closed long enough for such changes to occur, are within the design capabilities of each element, such that they meet the requirements defined in subsections 525.1435(a)(1) through (a)(5);
(amended 2001/10/24)

(3) have means to minimize the release of harmful or hazardous concentrations of hydraulic fluid or vapours into the crew and passenger compartments during flight;
(amended 2001/10/24)

(4) meet the applicable requirement of sections 525.863, 525.1183, 525.1185 and 525.1189 if a flammable hydraulic fluid is used; and
(amended 2001/10/24)

(5) be designed to use any suitable hydraulic fluid specified by the aeroplane manufacturer, which shall be identified by appropriate markings as required by section 525.1541.
(amended 2001/10/24)

(c) Tests. Tests shall be conducted on the hydraulic system(s), and/or subsystem(s) and elements, except that analysis may be used in place of or to supplement testing, where the analysis is shown to be reliable and appropriate. All internal and external influences shall be taken into account to an extent necessary to evaluate their effects, and to assure reliable system and element functioning and integration. Failure or unacceptable deficiency of an element or

system shall be corrected and be sufficiently retested, where necessary.
(amended 2001/10/24)

(1) The system(s), subsystem(s), or element(s) shall be subjected to performance, fatigue, and endurance tests representative of aeroplane ground and flight operations.
(amended 2001/10/24)

(2) The complete system shall be tested to determine proper functional performance and relation to the other systems, including simulation of relevant failure conditions, and to support or validate element design.
(amended 2001/10/24)

(3) The complete hydraulic system(s) shall be functionally tested on the aeroplane in normal operation over the range of motion of all associated user systems. The test shall be conducted at the system relief pressure or 1.25 times the DOP if a system pressure relief device is not part of the system design. Clearances between hydraulic system elements and other systems or structural elements shall remain adequate and there shall be no detrimental effects.
(amended 2001/10/24)

(Change 525-3 (91-11-01))

525.1438 *Pressurisation and Pneumatic Systems*

(a) Pressurisation system elements must be burst pressure tested to 2.0 times, and proof pressure tested to 1.5 times, the maximum normal operating pressure.

(b) Pneumatic system elements must be burst pressure tested to 3.0 times, and proof pressure tested to 1.5 times, the maximum normal operating pressure.

(c) An analysis, or a combination of analysis and test, may be substituted for any test required by paragraph *(a)* or *(b)* of this section if the Minister finds it equivalent to the required test.

525.1439 *Protective Breathing Equipment*

(a) Fixed (stationary or built in) protective breathing equipment shall be installed for the use of the flight crew, and at least one portable protective breathing equipment shall be located at or near the flight deck for use by a flight crew member. In addition, portable protective breathing equipment shall be installed for the use of appropriate crew members for fighting fires in compartments accessible in flight other than the flight deck. This includes isolated compartments and upper and lower lobe galleys, in which crew member occupancy is permitted during flight. Equipment shall be installed for the maximum number of crew members expected to be in the area during any operation.
(amended 2005/06/03)

(b) For protective breathing equipment required by paragraph *(a)* of this section or by any applicable operating rule:
(amended 2005/06/03)

(1) The equipment shall be designed to protect the appropriate crew member from smoke, carbon dioxide, and other harmful gases while on flight deck duty or while combating fires.
(amended 2005/06/03)

(2) The equipment shall include:
(amended 2005/06/03)

(i) Masks covering the eyes, nose, and mouth; or

(ii) Masks covering the nose and mouth, plus accessory equipment to cover the eyes.

(3) The equipment, including portable equipment, shall allow communication with other crew members while in use. Equipment available at flight crew assigned duty stations shall also enable the flight crew to use radio equipment.
(amended 2005/06/03)

(4) The part of the equipment protecting the eyes shall not cause any appreciable adverse effect on vision and shall allow corrective glasses to be worn.
(amended 2005/06/03)

(5) The equipment shall supply protective oxygen of 15 minutes duration per crew member at a pressure altitude of 8,000 feet with a respiratory minute volume of 30 litres per minute BTPD. The equipment and system shall be designed to prevent any inward leakage to the inside of the device and prevent any outward leakage causing significant increase in the oxygen content of the local ambient atmosphere. If a demand oxygen system is used, a supply of 300 litres of free oxygen at 70°F and 760 mm Hg pressure is considered to be of 15-minute duration at the prescribed altitude and minute volume. If a continuous flow open circuit protective breathing system is used a flow rate of 60 litres per minute at 8,000 feet (45 litres per minute at sea level) and a supply of 600 litres of free oxygen at 70°F and 760 mm. Hg pressure is considered to be of 15-minute duration at the prescribed altitude and minute volume. Continuous flow systems shall not increase the ambient oxygen content of the local atmosphere above that of demand systems. BTPD refers to body temperature conditions (that is, 37° C, at ambient pressure, dry).
(amended 2005/06/03)

(6) The equipment shall meet the requirements of 525.1441.
(amended 2005/06/03)

525.1441 *Oxygen Equipment and Supply*

(a) If certification with supplemental oxygen equipment is requested, the equipment must meet the requirements of this section and 525.1443 through 525.1453.

(b) The oxygen system must be free from hazards in itself, in its method of operation, and in its effect upon other components.

(c) There must be a means to allow the crew to readily determine, during flight, the quantity of oxygen available in each source of supply.

(d) The oxygen flow rate and the oxygen equipment for aeroplanes for which certification for operation above 40,000 feet is requested must be approved.

525.1443 *Minimum Mass Flow of Supplemental Oxygen*

(a) If continuous flow equipment is installed for use by flight crew members, the minimum mass flow of supplemental oxygen required for each crew member may not be less than the flow required to maintain, during inspiration, a mean tracheal oxygen partial pressure of 149 mm. Hg when breathing 15 litres per minute, BTPS, and with a maximum tidal volume of 700 cc. with a constant time interval between respirations.

(b) If demand equipment is installed for use by flight crew members, the minimum mass flow of supplemental oxygen required for each crew member may not be less than the flow required to maintain, during inspiration, a mean tracheal oxygen partial pressure of 122 mm. Hg, up to and including a cabin pressure altitude of 35,000 feet, and 95 percent oxygen between cabin pressure altitudes of 35,000 and 40,000 feet, when breathing 20 litres per minute BTPS. In addition, there must be means to allow the crew to use undiluted oxygen at their discretion.

(c) For passengers and cabin attendants, the minimum mass flow of supplemental oxygen required for each person at various cabin pressure altitudes may not be less than the flow required to maintain, during inspiration and while using the oxygen equipment (including masks) provided, the following mean tracheal oxygen partial pressures:

(1) At cabin pressure altitudes above 10,000 feet up to and including 18,500 feet, a mean tracheal oxygen partial pressure of 100 mm. Hg when breathing 15 litres per minute, BTPS, and with a tidal volume of 700 cc. with a constant time interval between respirations.

(2) At cabin pressure altitudes above 18,500 feet up to and including 40,000 feet, a mean tracheal oxygen partial pressure of 83.8 mm. Hg when breathing 30 litres per minute, BTPS, and with a tidal volume of 1,100 cc. with a constant time interval between respirations.

(d) If first-aid oxygen equipment is installed, the minimum mass flow of oxygen to each user may not be less than four litres per minute, STPD. However, there may be a means to decrease this flow to not less than two litres per minute, STPD, at any cabin altitude. The quantity of oxygen required is based upon an average flow rate of 3 litres per minute per person for whom first-aid oxygen is required.

(e) If portable oxygen equipment is installed for use by crew members, the minimum mass flow of supplemental oxygen is the same as specified in paragraph *(a)* or *(b)* of this section, whichever is applicable.

525.1445 *Equipment Standards for the Oxygen Distributing System*

(a) When oxygen is supplied to both crew and passengers, the distribution system must be designed for either:

(1) A source of supply for the flight crew on duty and a separate source for the passengers and other crew members; or

(2) A common source of supply with means to separately reserve the minimum supply required by the flight crew on duty.

(b) Portable walk-around oxygen units of the continuous flow, diluter-demand, and straight demand kinds may be used to meet the crew or passenger breathing requirements.

525.1447 *Equipment Standards for Oxygen Dispensing Units*

If oxygen dispensing units are installed, the following apply:

(a) There must be an individual dispensing unit for each occupant for whom supplemental oxygen is to be supplied. Units must be designed to cover the nose and mouth and must be equipped with a suitable means to retain the unit in position on the face. Flight crew masks for supplemental oxygen must have provisions for the use of communication equipment.

(b) If certification for operation up to and including 25,000 feet is requested, an oxygen supply terminal and unit of oxygen dispensing equipment for the immediate use of oxygen by each crew member must be within easy reach of that crew member. For any other occupants, the supply terminals and dispensing equipment must be located to allow the use of oxygen as required by the applicable operating rules.

(c) If certification for operation above 25,000 feet is requested, there must be oxygen dispensing equipment meeting the following requirements:

(1) There must be an oxygen dispensing unit connected to oxygen supply terminals immediately available to each occupant, wherever seated, and at least two oxygen dispensing units connected to oxygen terminals in each lavatory. The total number of dispensing units and outlets in the cabin must exceed the number of seats by at least 10 percent. The extra units must be as uniformly distributed throughout the cabin as practicable. If certification for operation above 30,000 feet is requested, the dispensing units providing the required oxygen flow must be automatically presented to the occupants before the cabin pressure altitude exceeds 15,000 feet. The crew must be provided with a manual means of making the dispensing units immediately available in the event of failure of the automatic system.

(2) Each flight crewmember on flight deck duty must be provided with a quick-donning type oxygen dispensing unit connected to an oxygen supply terminal. This dispensing unit must be immediately available to the flight crewmember when seated at his station, and installed so that it:

(i) Can be placed on the face from its ready position, properly secured, sealed, and supplying oxygen upon demand, with one hand, within five seconds and without disturbing eyeglasses or causing delay in proceeding with emergency duties; and

(ii) Allows, while in place, the performance of normal communication functions.

(3) The oxygen dispensing equipment for the flight crewmembers must be:

(i) The diluter demand or pressure demand (pressure demand mask with a diluter demand pressure breathing regulator) type, or other approved oxygen equipment shown to provide the same degree of protection, for aeroplanes to be operated above 25,000 feet.

(ii) The pressure demand (pressure demand mask with a diluter demand pressure breathing regulator) type with mask-mounted regulator, or other approved oxygen equipment shown to provide the same degree of protection, for aeroplanes operated at altitudes where decompressions that are not extremely improbable may expose the flight crew to cabin pressure altitudes in excess of 34,000 feet.

(4) Portable oxygen equipment shall be immediately available for each cabin attendant. The portable oxygen equipment shall have the oxygen dispensing unit connected to the portable oxygen supply.
(amended 2007/03/08)

(Change 525-8)

525.1449 *Means for Determining Use of Oxygen*

There must be a means to allow the crew to determine whether oxygen is being delivered to the dispensing equipment.

525.1450 *Chemical Oxygen Generators*

(a) For the purpose of this section, a chemical oxygen generator is defined as a device which produces oxygen by chemical reaction.

(b) Each chemical oxygen generator must be designed and installed in accordance with the following requirements:

(1) Surface temperature developed by the generator during operation may not create a hazard to the aeroplane or to its occupants.

(2) Means must be provided to relieve any internal pressure that may be hazardous.

(c) In addition to meeting the requirements in paragraph *(b)* of this section, each portable chemical oxygen generator that is capable of sustained operation by successive replacement of a generator element must be placarded to show:

(1) The rate of oxygen flow, in litres per minute;

(2) The duration of oxygen flow, in minutes, for the replaceable generator element; and

(3) A warning that the replaceable generator element may be hot, unless the element construction is such that the surface temperature cannot exceed 100 degrees F.

525.1451 *(Removed)*

(Change 525-3 (91-11-01))

525.1453 *Protection of Oxygen Equipment from Rupture*

Oxygen pressure tanks, and lines between tanks and the shut-off means, must be:

(a) Protected from unsafe temperatures; and

(b) Located where the probability and hazards of rupture in a crash landing are minimised.

525.1455 *Draining of Fluids Subject to Freezing*

If fluids subject to freezing may be drained overboard in flight or during ground operation, the drains must be designed and located to prevent the formation of hazardous quantities of ice on the aeroplane as a result of the drainage.

525.1457 *Cockpit Voice Recorders*

(a) Each cockpit voice recorder required by the applicable operating rules, must be approved and must be installed so that it will record the following:

(1) Voice communications transmitted from or received in the aeroplane by radio.

(2) Voice communications of flight crew members on the flight deck.

(3) Voice communications of flight crew members on the flight deck, using the aeroplane's interphone system.

(4) Voice or audio signals identifying navigation or approach aids introduced into a headset or speaker.

(5) Voice communications of flight crew members using the passenger loudspeaker system, if there is such a system and if the fourth channel is available in accordance with the requirements of (c)(4)(ii) of this section.

(6) If datalink communication equipment is installed, all datalink communications, using an approved data message set. Datalink messages must be recorded as the output signal from the communications unit that translates the signal into usable data.
(amended 2009/05/11)

(b) The recording requirements of paragraph *(a)*(2) of this section must be met by installing a cockpit-mounted area microphone, located in the best position for recording voice communications originating at the first and second pilot stations and voice communications of other crew members on the flight deck when directed to those stations. The microphone must be so located and, if necessary, the pre-amplifiers and filters of the recorder must be so adjusted or supplemented, that the intelligibility of the recorded communications is as high as practicable when recorded under flight cockpit noise conditions and played back. Repeated aural or visual playback of the record may be used in evaluating intelligibility.

(c) Each cockpit voice recorder must be installed so that the part of the communication or audio signals specified in paragraph *(a)* of this section obtained from each of the following sources is recorded on a separate channel:

(1) For the first channel, from each boom, mask or hand-held microphone, headset, or speaker used at the first pilot station.

(2) For the second channel, from each boom, mask or hand-held microphone, headset, or speaker used at the second pilot station.

(3) For the third channel, from the cockpit-mounted area microphone.

(4) For the fourth channel, from:

(i) Each boom, mask or hand-held microphone, headset, or speaker used at the stations for the third and fourth crew members; or

(ii) If the stations specified in subdivision (i) of this subparagraph are not required or if the signal at such a station is picked up by another channel, each microphone on the flight deck that is used with the passenger loudspeaker system, if its signals are not picked up by another channel.

(5) As far as is practicable all sounds received by the microphones listed in paragraphs (c)(1), (2), and (4) of this section must be recorded without interruption irrespective of the position of the interphone-transmitter key switch. The design shall ensure that sidetone for the flight crew is produced only when the interphone, public address system, or radio transmitters are in use.

(d) Each cockpit voice recorder must be installed so that:

(1) It receives its electric power from the bus that provides the maximum reliability for operation of the cockpit voice recorder without jeopardising service to essential or emergency loads. The cockpit voice recorder must remain powered for as long as possible without jeopardizing emergency operation of the aeroplane;
(amended 2009/05/11)

(2) There is an automatic means to simultaneously stop the recorder and prevent each erasure feature from functioning, within 10 minutes after crash impact;

(3) There is an aural or visual means for pre-flight checking of the recorder for proper operation;

(4) Any single electrical failure external to the recorder does not disable both the cockpit voice recorder and the flight data recorder;
(amended 2009/05/11)

(5) It has an independent power source:
(amended 2009/05/11)

(i) That provides 10 ± 1 minutes of electrical power to operate both the cockpit voice recorder and cockpit-mounted area microphone;
(amended 2009/05/11)

(ii) That is located as close as practicable to the cockpit voice recorder; and
(amended 2009/05/11)

(iii) To which the cockpit voice recorder and cockpit-mounted area microphone are switched automatically in the event that all other power to the cockpit voice recorder is interrupted either by normal shutdown or by any other loss of power to the electrical power bus; and
(amended 2009/05/11)

(6) It is in a separate container from the flight data recorder when both are required. If used to comply with only the cockpit voice recorder requirements, a combination unit may be installed.
(amended 2009/05/11)

(e) The record container must be located and mounted to minimise the probability of rupture of the container as a result of crash impact and consequent heat damage to the recorder from fire.
(amended 2009/05/11)

(1) Except as provided in (e)(2) of this section, the recorder container must be located as far aft as practicable, but need not be outside of the pressurised compartment, and must not be located where aft-mounted engines may crush the container during impact.
(amended 2009/05/11)

(2) If two separate combination digital flight data recorder and cockpit voice recorder units are installed instead of one cockpit voice recorder and one digital flight data recorder, the combination unit that is installed to comply with the cockpit voice recorder requirements

may be located near the cockpit.
(amended 2009/05/11)

(f) If the cockpit voice recorder has a bulk erasure device, the installation must be designed to minimise the probability of inadvertent operation and actuation of the device during crash impact.

(g) Each recorder container must:

(1) Be either bright orange or bright yellow;

(2) Have reflective tape affixed to its external surface to facilitate its location under water; and

(3) Have an underwater locating device, when required by the applicable operating rules, on or adjacent to the container which is secured in such manner that they are not likely to be separated during crash impact.

(Change 525-2 (89-01-01))

525.1459 *Flight Data Recorders*
(amended 2009/05/11)

(a) Each flight data recorder required by the applicable operating rules must be installed so that:
(amended 2009/05/11)

(1) It is supplied with airspeed, altitude, and directional data obtained from sources that meet the accuracy requirements of 525.1323, 525.1325, and 525.1327, as appropriate;

(2) The vertical acceleration sensor is rigidly attached, and located longitudinally either within the approved centre of gravity limits of the aeroplane, or at a distance forward or aft of these limits that does not exceed 25 percent of the aeroplane's mean aerodynamic chord;

(3) It receives its electrical power from the bus that provides the maximum reliability for operation of the flight data recorder without jeopardising service to essential or emergency loads. The flight data recorder must remain powered for as long as possible without jeopardizing emergency operation of the aeroplane;
(amended 2009/05/11)

(4) There is an aural or visual means for pre-flight checking of the recorder for proper recording of data in the storage medium;

(5) Except for recorders powered solely by the engine-driven electrical generator system, there is an automatic means to simultaneously stop a recorder that has a data erasure feature and prevent each erasure feature from functioning, within 10 minutes after crash impact;

(6) There is a means to record data from which the time of each radio transmission either to or from ATC can be determined;

(7) Any single electrical failure external to the recorder does not disable both the cockpit voice recorder and the flight data recorder; and
(amended 2009/05/11)

(8) It is in a separate container from the cockpit voice recorder when both are required. If used to comply with only the flight data recorder requirements, a combination unit may be installed. If a combination unit is installed as a cockpit voice recorder to comply with 525.1457(e)(2), a combination unit must be used to comply with this flight data recorder requirement.
(amended 2009/05/11)

(b) Each non-ejectable record container must be located and mounted so as to minimise the probability of container rupture resulting from crash impact and subsequent damage to the record from fire. In meeting this requirement the record container must be located as far aft as practicable, but need not be aft of the pressurised compartment, and may not be where aft-mounted engines may crush the container upon impact.

(c) A correlation must be established between the flight recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments. The correlation must cover the airspeed range over which the aeroplane is to be operated, the range of altitude to which the aeroplane is limited, and 360 degrees of heading. Correlation may be established on the ground as appropriate.

(d) Each recorder container must:

(1) Be either bright orange or bright yellow;

(2) Have reflective tape affixed to its external surface to facilitate its location under water; and

(3) Have an underwater locating device, when required by the applicable operating rules, on or adjacent to the container which is secured in such a manner that they are not likely to be separated during crash impact.

(e) Any novel or unique design or operational characteristics of the aircraft shall be evaluated to determine if any dedicated parameters must be recorded on flight recorders in addition to or in place of existing requirements.

(Change 525-2 (89-01-01))

525.1461 *Equipment Containing High Energy Rotors*

(a) Equipment containing high energy rotors must meet paragraph *(b)*, *(c)*, or *(d)* of this section.

(b) High energy rotors contained in equipment must be able to withstand damage caused by malfunctions, vibration, abnormal speeds, and abnormal temperatures. In addition:

(1) Auxiliary rotor cases must be able to contain damage caused by the failure of high energy rotor blades; and

(2) Equipment control devices, systems, and instrumentation must reasonably ensure that no operating limitations affecting the integrity of high energy rotors will be exceeded in service.

(c) It must be shown by test that equipment containing high energy rotors can contain any failure of a high energy rotor that occurs at the highest speed obtainable with the normal speed control devices inoperative.

Equipment containing high energy rotors must be located where rotor failure will neither endanger the occupants nor adversely affect continued safe flight.

SUBCHAPTER G

Operating Limitations and Information

525.1501 *General*

(a) Each operating limitation specified in 525.1503 through 525.1533 and other limitations and information necessary for safe operation must be established.

(b) The operating limitations and other information necessary for safe operation must be made available to the crewmembers as prescribed in 525.1541 through 525.1587.

Operating Limitations

525.1503 *Airspeed Limitations: General*

When airspeed limitations are a function of weight, weight distribution, altitude, or Mach number, limitations corresponding to each critical combination of these factors must be established.

525.1505 *Maximum Operating Limit Speed*

The maximum operating limit speed (V_{MO}/M_{MO} airspeed or Mach number, whichever is critical at a particular altitude) is a speed that may not be deliberately exceeded in any regime of flight (climb, cruise, or descent), unless a higher speed is authorised for flight test or pilot training operations. V_{MO}/M_{MO} must be established so that it is not greater than the design cruising speed V_C and so that it is sufficiently below V_D/M_D or V_{DF}/M_{DF}, to make it highly improbable that the latter speeds will be inadvertently exceeded in operations. The speed margin between V_{MO}/M_{MO} and V_D/M_D or V_{DF}/M_{DF} may not be less than that determined under 525.335(b) or found necessary during the flight tests conducted under 525.253.

525.1507 *Manoeuvring Speed*

The manoeuvring speed must be established so that it does not exceed the design manoeuvring speed V_A determined under 525.335(c).

525.1511 *Flap Extended Speed*

The established flap extended speed V_{FE} must be established so that it does not exceed the design flap speed V_F chosen under 525.335(e) and 525.345, for the corresponding flap positions and engine powers.

525.1513 *Minimum Control Speed*

The minimum control speed V_{MC} determined under 525.149 must be established as an operating limitation.

525.1515 *Landing Gear Speeds*

(a) The established landing gear operating speed or speeds, V_{LO}, may not exceed the speed at which it is safe both to extend and to retract the landing gear, as determined under 525.729 or by flight characteristics. If the extension speed is not the same as the retraction speed, the two speeds must be designated as $V_{LO(EXT)}$ and $V_{LO(RET)}$, respectively.

(b) The established landing gear extended speed V_{LE} may not exceed the speed at which it is safe to fly with the landing gear secured in the fully extended position, and that determined under 525.729.

525.1516 *Other Speed Limitations*

Any other limitation associated with speed shall be established.
(amended 2001/10/24)

525.1517 *Rough Air Speed, V_{RA}*

A rough air speed, V_{RA}, for use as the recommended turbulence penetration airspeed in 525.1585(a)(8), must be established, which:

(a) Is not greater than the design airspeed for maximum gust intensity, selected for V_B; and

(b) Is not less than the minimum value of V_B specified in 525.335*(d)*; and

(c) Is sufficiently less than V_{MO} to ensure that likely speed variation during rough air encounters will not cause the overspeed warning to operate too frequently. In the absence of a rational investigation substantiating the use of other values, V_{RA} must be less than V_{MO}- 35 knots (TAS).

(Change 525-8)

525.1519 *Weight, Centre of Gravity and Weight Distribution*

The aeroplane weight, centre of gravity, and weight distribution limitations determined under 525.23 through 525.27 must be established as operating limitations.

525.1521 *Powerplant Limitations*

(a) General. The powerplant limitations prescribed in this section must be established so that they do not exceed the corresponding limits for which the engines or propellers are type certificated and do not exceed the values on which compliance with any other requirement of this chapter is based.

(b) Reciprocating engine installations. Operating limitations relating to the following must be established for reciprocating engine installations:

(1) Horsepower or torque, r.p.m., manifold pressure, and time at critical pressure altitude and sea level pressure altitude for:

(i) Maximum continuous power (relating to unsupercharged operation or to operation in each supercharger mode as applicable); and

(ii) Take-off power (relating to unsupercharged operation or to operation in each supercharger mode as applicable).

(2) Fuel grade or specification.

(3) Cylinder head and oil temperatures.

(4) Any other parameter for which a limitation has been established as part of the engine type certificate except that a limitation need not be established for a parameter that cannot be exceeded during normal operation due to the design of the installation or to another established limitation.

(c) Turbine engine installations. Operations limitations relating to the following must be established for turbine engine installation:

(1) Horsepower, torque or thrust, r.p.m., gas temperature, and time for:

(i) Maximum continuous power or thrust (relating to augmented or unaugmented operation as applicable).

(ii) Take-off power or thrust (relating to augmented or unaugmented operation as applicable).

(2) Fuel designation or specification.

(3) Any other parameter for which a limitation has been established as part of the engine type certificate except that a limitation need not be established for a parameter that cannot be exceeded during normal operation due to the design of the installation or to another established limitation.

(d) Ambient temperature. An ambient temperature limitation (including limitations for winterisation installations, if applicable) must be established as the maximum ambient atmospheric temperature established in accordance with 525.1043*(b)*.

(e) *Take-off operation.* For all engine installations, the power plant take-off operation must be limited by a time limit for conditional use of rated take-off power or thrust in excess of 5 minutes, but not more than 10, in case of one-engine-inoperative climb, if:

(1) The engine has been type approved for such operation; and

(2) The instructions for continued airworthiness contain instructions for mandatory actions shown to be necessary following operation of an engine in excess of 5 minutes at take-off rating.

FAR: No equivalent text

(Change 525-3 (91-11-01))

525.1522 *Auxiliary Power Unit Limitations*

If an auxiliary power unit is installed in the aeroplane, limitations established for that auxiliary power unit, including the categories of operation, must be specified as operating limitations for the aeroplane.

(Change 525-3 (91-11-01))

525.1523 *Minimum Flight Crew*

The minimum flight crew must be established so that it is sufficient for safe operation, considering:

(a) The workload on individual crewmembers;

(b) The accessibility and ease of operation of necessary controls by the appropriate crewmember; and

(c) The kind of operation authorised under 525.1525.

The criteria used in making the determinations required by this section are set forth in Appendix D.

525.1525 *Kinds of Operation*

The kinds of operation to which the aeroplane is limited are established by the category in which it is eligible for certification and by the installed equipment.

525.1527 *Ambient Air Temperature and Operating Altitude*

The extremes of the ambient air temperature and operating altitude for which operation is allowed, as limited by flight, structural, powerplant, functional, or equipment characteristics, shall be established.
(amended 2001/10/24)

525.1529 *Instructions for Continued Airworthiness*

The applicant must prepare Instructions for Continued Airworthiness in accordance with Appendix H to this chapter that are acceptable to the Minister. The instructions may be incomplete at type certification if a program exists to ensure their completion prior to delivery of the first aeroplane or issuance of a standard certificate of airworthiness, whichever occurs later.

525.1531 *Manoeuvring Flight Load Factors*

Load factor limitations, not exceeding the positive limit load factors determined from the manoeuvring diagram in 525.333(b), must be established.

525.1533 *Additional Operating Limitations*

(a) Additional operating limitations must be established as follows:

(1) The maximum take-off weights must be established as the weights at which compliance is shown with the applicable provisions of this chapter (including the take-off climb provisions of 525.121(a) through (c), for altitudes and ambient temperatures).

(2) The maximum landing weights must be established as the weights at which compliance is shown with the applicable provisions of this chapter (including the landing and approach climb provisions of 525.119 and 525.121(d) for altitudes and ambient temperatures).

(3) The minimum take-off distances must be established as the distances at which compliance is shown with the applicable provisions of this chapter (including the provisions of 525.109 and 525.113, for weights, altitudes, temperatures, wind components, runway surface conditions (dry and wet) and runway gradients) for smooth, hard-surfaced runways. Additionally, at the option of the applicant, wet runway take-off distances may be established for runway surfaces that have been grooved and may be approved for use on runways where such surfaces have been designed constructed, and maintained in a manner acceptable to the Minister.

(b) The extremes for variable factors (such as altitude, temperature, wind, and runway gradients) are those at which compliance with the applicable provisions of this chapter is shown.

(Change 525-3 (91-11-01))
(Change 525-8)

Markings and Placards

525.1541 *General*

(a) The aeroplane must contain:

(1) The specified markings and placards; and

(2) Any additional information, instrument markings, and placards required for the safe operation if there are unusual design, operating, or handling characteristics.

(b) Each marking and placard prescribed in paragraph *(a)* of this section:

(1) Must be displayed in a conspicuous place; and

(2) May not be easily erased, disfigured, or obscured.

525.1543 *Instrument Markings: General*

For each instrument:

(a) When markings are on the cover glass of the instrument, there must be means to maintain the correct alignment of the glass cover with the face of the dial; and

(b) Each instrument marking must be clearly visible to the appropriate crewmember.

(Change 525-3 (91-11-01))

525.1545 *Airspeed Limitation Information*

The airspeed limitations required by 525.1583(a) must be easily read and understood by the flight crew.

525.1547 *Magnetic Direction Indicator*

(a) A placard meeting the requirements of this section must be installed on, or near, the magnetic direction indicator.

(b) The placard must show the calibration of the instrument in level flight with the engines operating.

(c) The placard must state whether the calibration was made with radio receivers on or off.

(d) Each calibration reading must be in terms of magnetic heading in not more than 45-degree increments.

525.1549 *Powerplant and Auxiliary Power Unit Instruments*

For each required powerplant and auxiliary power unit instrument, as appropriate to the type of instrument:

(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;

(b) Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits;

(c) Each take-off and precautionary range must be marked with a yellow arc or a yellow line; and

(d) Each engine, auxiliary power unit, or propeller speed range that is restricted because of excessive vibration stresses must be marked with red arcs or red lines.

525.1551 *Oil Quantity Indicator*

Each oil quantity indicating means must be marked to indicate the quantity of oil readily and accurately.

(Change 525-3 (91-11-01))

525.1553 *Fuel Quantity Indicator*

If the unusable fuel supply for any tank exceeds one gallon, or five percent of the tank capacity, whichever is greater, a red arc must be marked on its indicator extending from the calibrated zero reading to the lowest reading obtainable in level flight.

525.1555 *Control Markings*

(a) Each cockpit control, other than primary flight controls and controls whose function is obvious, must be plainly marked as to its function and method of operation.

(b) Each aerodynamic control must be marked under the requirements of 525.677 and 525.699.

(c) For powerplant fuel controls:

(1) Each fuel tank selector control must be marked to indicate the position corresponding to each tank and to each existing cross feed position;

(2) If safe operation requires the use of any tanks in a specific sequence, that sequence must be marked on, or adjacent to, the selector for those tanks; and

(3) Each valve control for each engine must be marked to indicate the position corresponding to each engine controlled.

(d) For accessory, auxiliary, and emergency controls:

(1) Each emergency control (including each fuel jettisoning and fluid shut-off control) must be coloured red; and

(2) Each visual indicator required by 525.729(e) must be marked so that the pilot can determine at any time when the wheels are locked in either extreme position, if retractable landing gear is used.

525.1557 *Miscellaneous Markings and Placards*

(a) Baggage and cargo compartments and ballast location. Each baggage and cargo compartment, and each ballast location must have a placard stating any limitations on contents, including weight, that are necessary under the loading requirements. However, under seat compartments designed for the storage of carry-on articles weighing not more than 20 pounds need not have a loading limitation placard.

(b) Powerplant fluid filler openings.

(1) Fuel filler openings must be marked at or near the filler cover with:

(i) The word "fuel";

(ii) For reciprocating engine powered aeroplanes, the minimum fuel grade;

(iii) For turbine engine powered aeroplanes, the permissible fuel designations; and

(iv) For pressure fuelling systems, the maximum permissible fuelling supply pressure and the maximum permissible defuelling pressure.

(2) Oil filler openings must be marked at or near the filler cover with the word "oil".

(3) Augmentation fluid filler openings must be marked at or near the filler cover to identify the required fluid.

<u>(4) If placards and markings at the powerplant fluid openings include tank capacity, the capacity must be specified in litres. Imperial or U.S. gallons may also be included.</u>

FAR: No equivalent text

(c) Emergency exit placards. Each emergency exit placard must meet the requirements of 525.811.

(d) Doors. Each door that must be used in order to reach any required emergency exit must have a suitable placard stating that the door is to be latched in the open position during take-off and landing.

(Change 525-3 (91-11-01))

525.1561 *Safety Equipment*

(a) Each safety equipment control to be operated by the crew in emergency, such as controls for automatic liferaft releases, must be plainly marked as to its method of operation.

(b) Each location, such as a locker or compartment, that carries any fire extinguishing, signalling, or other lifesaving equipment must be marked accordingly.

(c) Stowage provisions for required emergency equipment must be conspicuously marked to identify the contents and facilitate the easy removal of the equipment.

(d) Each liferaft must have obviously marked operating instructions.

(e) Approved survival equipment must be marked for identification and method of operation.

525.1563 *Airspeed Placard*

A placard showing the maximum airspeeds for flap extension for the take-off, approach, and landing positions must be installed in clear view of each pilot.

Aeroplane Flight Manual

525.1581 *General*

(a) *Furnishing information.* An *Aeroplane Flight Manual* must be furnished with each aeroplane, and it must contain the following:

(1) Information required by 525.1583 through 525.1587.

(2) Other information that is necessary for safe operation because of design, operating, or handling characteristics.

(3) Any limitation, procedure, or other information established as a condition of compliance with the applicable noise standards of Chapter 516, Subchapter A of this manual.
(amended 2007/07/16)

FAR: (3) Any limitation, procedure, or other information established as a condition of compliance with the applicable noise standards of Part 36 of this chapter.

(b) *Approved information.* Each part of the manual listed in 525.1583 through 525.1587, that is appropriate to the aeroplane, must be furnished, verified, and approved, and must be segregated, identified, and clearly distinguished from each unapproved part of that manual.

(c) (Reserved)

(d) Each *Aeroplane Flight Manual* must include a table of contents if the complexity of the manual indicates a need for it.

(e) (Removed)
(amended 2003/06/01)

(f) (Removed)
(amended 2003/06/01)

(g) The *Aeroplane Flight Manual* shall contain information in the form of approved guidance material for supplementary operating procedures and performance information for operating on contaminated runways.

FAR: No equivalent text

(Change 525-3 (91-11-01))
(Change 525-6 (93-12-30))
(Change 525-8)

525.1583 *Operating Limitations*

(a) Airspeed Limitations. The following airspeed limitations and any other airspeed limitations necessary for safe operation must be furnished:

(1) The maximum operating limit speed V_{MD}/M_{MO} and a statement that this speed limit may not be deliberately exceeded in any regime of flight (climb, cruise, or descent) unless a higher speed is authorised for flight test or pilot training.

(2) If an airspeed limitation is based upon compressibility effects, a statement to this effect and information as to any symptoms, the probable behaviour of the aeroplane, and the recommended recovery procedures.

(3) The manoeuvring speed established under section 525.1507 and statements, as applicable to the particular design, explaining that:
(amended 2012/03/27)

(i) Full application of pitch, roll or yaw controls should be confined to speeds below the manoeuvring speed; and
(amended 2012/03/27)

(ii) rapid and large alternating control inputs, especially in combination with large changes in pitch, roll or yaw, and full control inputs in more than one axis at the same

time, should be avoided as they may result in structural failures at any speed, including below the manoeuvring speed.
(amended 2012/03/27)

(4) The flap extended speed V_{FE} and the pertinent flap positions and engine powers.

(5) The landing gear operating speed or speeds, and a statement explaining the speeds as defined in 525.1515(a).

(6) The landing gear extended speed V_{LE}, if greater than V_{LO}, and a statement that this is the maximum speed at which the aeroplane can be safely flown with the landing gear extended.

(b) Powerplant limitations. The following information must be furnished:

(1) Limitations required by 525.1521 and 525.1522.

(2) Explanation of the limitations, when appropriate.

(3) Information necessary for marking the instruments required by 525.1549 through 525.1553.

(c) Weight and loading distribution. The weight and centre of gravity limitations established under section 525.1519 shall be furnished in the *Aeroplane Flight Manual*. All of the following information, including the weight distribution limitations established under section 525.1519, shall be presented either in the *Aeroplane Flight Manual* or in a separate weight and balance control and loading document that is incorporated by reference in the *Aeroplane Flight Manual*:
(amended 2001/10/24)

(1) The condition of the aeroplane and the items included in the empty weight as defined in accordance with 525.29.

(2) Loading instructions necessary to ensure loading of the aeroplane within the weight and centre of gravity limits, and to maintain the loading within these limits in flight.

(3) If certification for more than one centre of gravity range is requested, the appropriate limitations, with regard to weight and loading procedures, for each separate centre of gravity range.

(d) Flight crew. The number and functions of the minimum flight crew determined under 525.1523 must be furnished.

(e) Kinds of operation. The kinds of operation approved under 525.1525 must be furnished.

(f) Ambient Air Temperatures and Operating Altitudes. The extremes of the ambient air temperatures and operating altitudes established under 525.1527 shall be furnished.
(amended 2001/10/24)

(g) (Reserved)

(h) Additional operating limitations. The operating limitations established under 525.1533 must be furnished.

(i) *Manoeuvring flight load factors.* The positive manoeuvring limit load factors for which the structure is proven, described in terms of accelerations, must be furnished.

(Change 525-3 (91-11-01)
(Change 525-6 (93-12-30))

525.1585 *Operating Procedures*

(a) Operating procedures shall be furnished for:
(amended 2001/10/24)

(1) normal procedures peculiar to the particular type or model encountered in connection with routine operations;

(2) non-normal procedures for malfunction cases and failure conditions involving the use of special systems or the alternative use of regular systems; and

(3) emergency procedures for foreseeable but unusual situations in which immediate and precise action by the crew may be expected to substantially reduce the risk of catastrophe.

(b) Information or procedures not directly related to airworthiness or not under the control of the crew shall not be included, nor shall any procedure that is accepted as basic airmanship.
(amended 2001/10/24)

(c) Information identifying each operating condition in which the fuel system independence prescribed in section 525.953 is necessary for safety shall be furnished, together with instructions for placing the fuel system in a configuration used to show compliance with that section.
(amended 2001/10/24)

(d) The buffet onset envelopes, determined under section 525.251 shall be furnished. The buffet onset envelopes presented may reflect the centre of gravity at which the aeroplane is normally loaded during cruise if corrections for the effect of different centre of gravity locations are furnished.
(amended 2001/10/24)

(e) Information shall be furnished that indicates that when the fuel quantity indicator reads "zero" in level flight, any fuel remaining in the fuel tank cannot be used safely in flight.
(amended 2001/10/24)

(f) Information on the total quantity of usable fuel for each fuel tank shall be furnished.
(amended 2001/10/24)

525.1587 *Performance Information*

(a) Each *Aeroplane Flight Manual* must contain information to permit conversion of the indicated temperature to free air temperature if other than a free air temperature indicator is used to comply with the requirements of 525.1303*(a)*(1).

(b) Each *Aeroplane Flight Manual* shall contain the performance information computed under the applicable provisions of this chapter (including sections 525.115, 525.123 and 525.125 for the weights, altitudes, temperatures, wind components, and runway gradients, as applicable) within the operational limits of the aeroplane, and shall contain the following:
(amended 2001/10/24)

(1) in each case, the conditions of power, configuration, and speeds, and the procedures for handling the aeroplane and any system having a significant effect on the performance

information;
(amended 2001/10/24)

(2) V_{SR} determined in accordance with 525.103;
(amended 2003/11/10)

(3) the following performance information (determined by extrapolation and computed for the range of weights between the maximum landing weight and the maximum take-off weights):
(amended 2001/10/24)

(i) Climb in the landing configuration;

(ii) Climb in the approach configuration;

(iii) Landing distance;

(4) procedures established under 525.101(f) and (g) that are related to the limitations and information required by 525.1533 and by paragraph (b) in the form of guidance material, including any relevant limitations or information;
(amended 2001/10/24)

(5) an explanation of significant or unusual flight or ground handling characteristics of the aeroplane;

(6) corrections to indicated values of airspeed, altitude, and outside air temperature;
(amended 2001/10/24)

(7) an explanation of operational landing runway length factors included in the presentation of the landing distance, if appropriate.
(amended 2001/10/24)

(Change 525-3 (91-11-01))

SUBCHAPTER H
(amended 2009/05/11)

Electrical Wiring Interconnection Systems (EWIS)
(amended 2009/05/11)

525.1701 *Definition*
(amended 2009/05/11)

(a) As used in this chapter, electrical wiring interconnection system (EWIS) means any wire, wiring device, or combination of these, including termination devices, installed in any area of the aeroplane for the purpose of transmitting electrical energy, including data and signals, between two or more intended termination points. This includes:
(amended 2009/05/11)

(1) Wires and cables.
(amended 2009/05/11)

(2) Bus bars.
(amended 2009/05/11)

(3) The termination point on electrical devices, including those on relays, interrupters, switches, contactors, terminal blocks and circuit breakers, and other circuit protection devices.
(amended 2009/05/11)

(4) Connectors, including feed-through connectors.
(amended 2009/05/11)

(5) Connector accessories.
(amended 2009/05/11)

(6) Electrical grounding and bonding devices and their associated connections.
(amended 2009/05/11)

(7) Electrical splices.
(amended 2009/05/11)

(8) Materials used to provide additional protection for wires, including wire insulation, wire sleeving, and conduits that have electrical termination for the purpose of bonding.
(amended 2009/05/11)

(9) Shields or braids.
(amended 2009/05/11)

(10) Clamps and other devices used to route and support the wire bundle.
(amended 2009/05/11)

(11) Cable tie devices.
(amended 2009/05/11)

(12) Labels or other means of identification.
(amended 2009/05/11)

(13) Pressure seals.
(amended 2009/05/11)

(14) EWIS components inside shelves, panels, racks, junction boxes, distribution panels, and back-planes of equipment racks, including, but not limited to, circuit board back-planes, wire integration units, and external wiring of equipment.
(amended 2009/05/11)

(b) Except for the equipment indicated in (a)(14) of this section, EWIS components inside the following equipment, and the external connectors that are part of that equipment, are excluded from the definition in (a) of this section:
(amended 2009/05/11)

(1) Electrical equipment or avionics that are qualified to environmental conditions and testing procedures when those conditions and procedures are:
(amended 2009/05/11)

(i) Appropriate for the intended function and operating environment, and
(amended 2009/05/11)

(ii) Acceptable to the Minister.
(amended 2009/05/11)

(2) Portable electrical devices that are not part of the type design of the aeroplane. This includes personal entertainment devices and laptop computers.
(amended 2009/05/11)

(3) Fiber optics.
(amended 2009/05/11)

525.1703 *Function and Installation: EWIS*

(amended 2009/05/11)

(a) Each EWIS component installed in any area of the aircraft must:
(amended 2009/05/11)

(1) Be of a kind and design appropriate to its intended function.
(amended 2009/05/11)

(2) Be installed according to limitations specified for the EWIS components.
(amended 2009/05/11)

(3) Perform the function for which it was intended without degrading the airworthiness of the aeroplane.
(amended 2009/05/11)

(4) Be designed and installed in a way that will minimize mechanical strain.
(amended 2009/05/11)

(b) Selection of wires must take into account known characteristics of the wire in relation to each installation and application to minimize the risk of wire damage, including any arc tracking phenomena.
(amended 2009/05/11)

(c) The design and installation of the main power cables (including generator cables) in the fuselage must allow for a reasonable degree of deformation and stretching without failure.
(amended 2009/05/11)

(d) EWIS components located in areas of known moisture accumulation must be protected to minimize any hazardous effects due to moisture.
(amended 2009/05/11)

525.1705 *Systems and Functions: EWIS*

(amended 2009/05/11)

(a) EWIS associated with any system required for type certification or by operating rules must be considered an integral part of that system and must be considered in showing compliance with the applicable requirements for that system.
(amended 2009/05/11)

(b) For systems to which the following rules apply, the components of EWIS associated with those systems must be considered an integral part of that system or systems and must be considered in showing compliance with the applicable requirements for that system.
(amended 2009/05/11)

(1) 525.773(b)(2) Pilot compartment view.
(amended 2009/05/11)

(2) 525.981 Fuel tank ignition prevention.
(amended 2009/05/11)

(3) 525.1165 Engine ignition systems.
(amended 2009/05/11)

(4) 525.1310 Power source capacity and distribution.
(amended 2009/05/11)

(5) 525.1316 System lightning protection.
(amended 2009/05/11)

(6) 525.1331(a)(2) Instruments using a power supply.
(amended 2009/05/11)

(7) 525.1351 General.
(amended 2009/05/11)

(8) 525.1355 Distribution system.
(amended 2009/05/11)

(9) 525.1360 Precautions against injury.
(amended 2009/05/11)

(10) 525.1362 Electrical supplies for emergency conditions.
(amended 2009/05/11)

(11) 525.1365 Electrical appliances, motors and transformers.
(amended 2009/05/11)

(12) 525.1431(c) and (d) Electronic equipment.
(amended 2009/05/11)

525.1707 *System Separation: EWIS*
(amended 2009/05/11)

(a) Each EWIS must be designed and installed with adequate physical separation from other EWIS and aeroplane systems so that an EWIS component failure will not create a hazardous condition. Unless otherwise stated, for the purposes of this section, adequate physical separation must be achieved by separation distance or by a barrier that provides protection equivalent to that separation distance.
(amended 2009/05/11)

(b) Each EWIS must be designed and installed so that any electrical interference likely to be present in the aeroplane will not result in hazardous effects upon the aeroplane or its systems.
(amended 2009/05/11)

(c) Wires and cables carrying heavy current, and their associated EWIS components, must be designed and installed to ensure adequate physical separation and electrical isolation so that damage to circuits associated with essential functions will be minimized under fault

conditions.
(amended 2009/05/11)

(d) Each EWIS associated with independent aeroplane power sources or power sources connected in combination must be designed and installed to ensure adequate physical separation and electrical isolation so that a fault in any one aeroplane power source EWIS will not adversely affect any other independent power sources. In addition:
(amended 2009/05/11)

(1) Aeroplane independent electrical power sources must not share a common ground terminating location.
(amended 2009/05/11)

(2) Aeroplane system static grounds must not share a common ground terminating location with any of the aeroplane's independent electrical power sources.
(amended 2009/05/11)

(e) Except to the extent necessary to provide electrical connection to the fuel systems components, the EWIS must be designed and installed with adequate physical separation from fuel lines and other fuel system components, so that:
(amended 2009/05/11)

(1) An EWIS component failure will not create a hazardous condition.
(amended 2009/05/11)

(2) Any fuel leakage onto EWIS components will not create a hazardous condition.
(amended 2009/05/11)

(f) Except to the extent necessary to provide electrical connection to the hydraulic systems components, EWIS must be designed and installed with adequate physical separation from hydraulic lines and other hydraulic system components, so that:
(amended 2009/05/11)

(1) An EWIS component failure will not create a hazardous condition.
(amended 2009/05/11)

(2) Any hydraulic fluid leakage onto EWIS components will not create a hazardous condition.
(amended 2009/05/11)

(g) Except to the extent necessary to provide electrical connection to the oxygen systems components, EWIS must be designed and installed with adequate physical separation from oxygen lines and other oxygen system components, so that an EWIS component failure will not create a hazardous condition.
(amended 2009/05/11)

(h) Except to the extent necessary to provide electrical connection to the water/waste systems components, EWIS must be designed and installed with adequate physical separation from water/waste lines and other water/waste system components, so that:
(amended 2009/05/11)

(1) An EWIS component failure will not create a hazardous condition.
(amended 2009/05/11)

(2) Any water/waste leakage onto EWIS components will not create a hazardous condition.
(amended 2009/05/11)

(i) EWIS must be designed and installed with adequate physical separation between the EWIS and flight or other mechanical control systems cables and associated system components, so that:
(amended 2009/05/11)

(1) Chafing, jamming or other interference are prevented.
(amended 2009/05/11)

(2) An EWIS component failure will not create a hazardous condition.
(amended 2009/05/11)

(3) Failure of any flight or other mechanical control systems cables or systems components will not damage the EWIS and create a hazardous condition.
(amended 2009/05/11)

(j) EWIS must be designed and installed with adequate physical separation between the EWIS components and heated equipment, hot air ducts, and lines, so that:
(amended 2009/05/11)

(1) An EWIS component failure will not create a hazardous condition.
(amended 2009/05/11)

(2) Any hot air leakage or heat generated onto EWIS components will not create a hazardous condition.
(amended 2009/05/11)

(k) For systems for which redundancy is required, by certification rules, by operating rules, or as a result of the assessment required by 525.1709, EWIS components associated with those systems must be designed and installed with adequate physical separation.
(amended 2009/05/11)

(l) Each EWIS must be designed and installed so there is adequate physical separation between it and other aeroplane components and aeroplane structure, and so that the EWIS is protected from sharp edges and corners, to minimize potential for abrasion/chafing, vibration damage, and other types of mechanical damage.
(amended 2009/05/11)

525.1709 *System Safety: EWIS*
(amended 2009/05/11)

Each EWIS must be designed and installed so that:
(amended 2009/05/11)

(a) Each catastrophic failure condition:
(amended 2009/05/11)

(1) Is extremely improbable; and
(amended 2009/05/11)

(2) Does not result from a single failure.
(amended 2009/05/11)

(b) Each hazardous failure condition is extremely remote.
(amended 2009/05/11)

525.1711 *Component Identification: EWIS*
(amended 2009/05/11)

(a) EWIS components must be labeled or otherwise identified using a consistent method that facilitates identification of the EWIS component, its function, and its design limitations, if any.
(amended 2009/05/11)

(b) For systems for which redundancy is required, by certification rules, by operating rules, or as a result of the assessment required by 525.1709, EWIS components associated with those systems must be specifically identified with component part number, function, and separation requirement for bundles.
(amended 2009/05/11)

(1) The identification must be placed along the wire, cable, or wire bundle at appropriate intervals and in areas of the aeroplane where it is readily visible to maintenance, repair or alteration personnel.
(amended 2009/05/11)

(2) If an EWIS component cannot be marked physically, then other means of identification must be provided.
(amended 2009/05/11)

(c) The identifying markings required by (a) and (b) of this section must remain legible throughout the expected service life of the EWIS component.
(amended 2009/05/11)

(d) The means used for identifying each EWIS component as required by this section must not have an adverse effect on the performance of that component throughout its expected service life.
(amended 2009/05/11)

(e) Identification for EWIS modifications to the type design must be consistent with the identification scheme of the original type design.
(amended 2009/05/11)

525.1713 *Fire Protection: EWIS*
(amended 2009/05/11)

(a) All EWIS components must meet the applicable fire and smoke protection requirements of 525.831(c) of this chapter.
(amended 2009/05/11)

(b) EWIS components that are located in designated fire zones and used during emergency procedures must be fire-resistant.
(amended 2009/05/11)

(c) Insulation on electrical wire and electrical cable, and materials used to provide additional protection for the wire and cable, installed in any area of the aeroplane, must be self-extinguishing when tested in accordance with the applicable portions of Appendix F, part I, of this chapter.
(amended 2009/05/11)

525.1715 *Electrical Bonding and Protection Against Static Electricity: EWIS*
(amended 2009/05/11)

(a) EWIS components used for electrical bonding and protection against static electricity must meet the requirements of 525.899.
(amended 2009/05/11)

(b) On aeroplanes having grounded electrical systems, electrical bonding provided by EWIS components must provide an electrical return path capable of carrying both normal and fault currents without creating a shock hazard or damage to the EWIS components, other aeroplane system components, or aeroplane structure.
(amended 2009/05/11)

525.1717 *Circuit Protective Devices: EWIS*
(amended 2009/05/11)

Electrical wires and cables must be designed and installed so they are compatible with the circuit protection devices required by 525.1357, so that a fire or smoke hazard cannot be created under temporary or continuous fault conditions.
(amended 2009/05/11)

525.1719 *Accessibility Provisions: EWIS*
(amended 2009/05/11)

Access must be provided to allow inspection and replacement of any EWIS component as necessary for continued airworthiness.
(amended 2009/05/11)

525.1721 *Protection of EWIS*
(amended 2009/05/11)

(a) No cargo or baggage compartment must contain any EWIS whose damage or failure may affect safe operation, unless the EWIS is protected so that:
(amended 2009/05/11)

(1) It cannot be damaged by movement of cargo or baggage in the compartment.
(amended 2009/05/11)

(2) Its breakage or failure will not create a fire hazard.
(amended 2009/05/11)

(b) EWIS must be designed and installed to minimize damage and risk of damage to EWIS by movement of people in the aeroplane during all phases of flight, maintenance, and servicing.
(amended 2009/05/11)

(c) EWIS must be designed and installed to minimize damage and risk of damage to EWIS by items carried onto the aeroplane by passengers or cabin crew.
(amended 2009/05/11)

525.1723 *Flammable Fluid Fire Protection: EWIS*
(amended 2009/05/11)

EWIS components located in each area where flammable fluid or vapors might escape by leakage of a fluid system must be considered a potential ignition source and must meet the requirements of 525.863.
(amended 2009/05/11)

525.1725 *Powerplants: EWIS*
(amended 2009/05/11)

(a) EWIS associated with any powerplant must be designed and installed so that the failure of an EWIS component will not prevent the continued safe operation of the remaining powerplants or require immediate action by any crew member for continued safe operation, in accordance with the requirements of 525.903(b).
(amended 2009/05/11)

(b) Design precautions must be taken to minimize hazards to the aeroplane due to EWIS damage in the event of a powerplant rotor failure or a fire originating within the powerplant that burns through the powerplant case, in accordance with the requirements of 525.903(d)(1).
(amended 2009/05/11)

525.1727 *Flammable Fluid Shutoff Means: EWIS*
(amended 2009/05/11)

EWIS associated with each flammable fluid shutoff means and control must be fireproof or be located and protected so that any fire in a fire zone will not affect operation of the flammable fluid shutoff means, in accordance with the requirements of 525.1189.
(amended 2009/05/11)

525.1729 *Instructions for Continued Airworthiness: EWIS*
(amended 2009/05/11)

The applicant must prepare Instructions for Continued Airworthiness applicable to EWIS in accordance with Appendix H sections H525.4 and H525.5 of this chapter that are approved by the minister.
(amended 2009/05/11)

525.1731 *Powerplant and APU Fire Detector System: EWIS*
(amended 2009/05/11)

(a) EWIS that are part of each fire or overheat detector system in a fire zone must be fire-resistant.
(amended 2009/05/11)

(b) No EWIS component of any fire or overheat detector system for any fire zone must pass through another fire zone, unless:
(amended 2009/05/11)

(1) It is protected against the possibility of false warnings resulting from fires in zones through which it passes; or
(amended 2009/05/11)

(2) Each zone involved is simultaneously protected by the same detector and extinguishing system.
(amended 2009/05/11)

(c) EWIS that are part of each fire or overheat detector system in a fire zone must meet the requirements of 525.1203.
(amended 2009/05/11)

525.1733 *Fire Detector Systems, General: EWIS*
(amended 2009/05/11)

EWIS associated with any installed fire protection system, including those required by 525.854 and 525.858, must be considered an integral part of the system in showing compliance with the applicable requirements for that system.
(amended 2009/05/11)

APPENDIX A

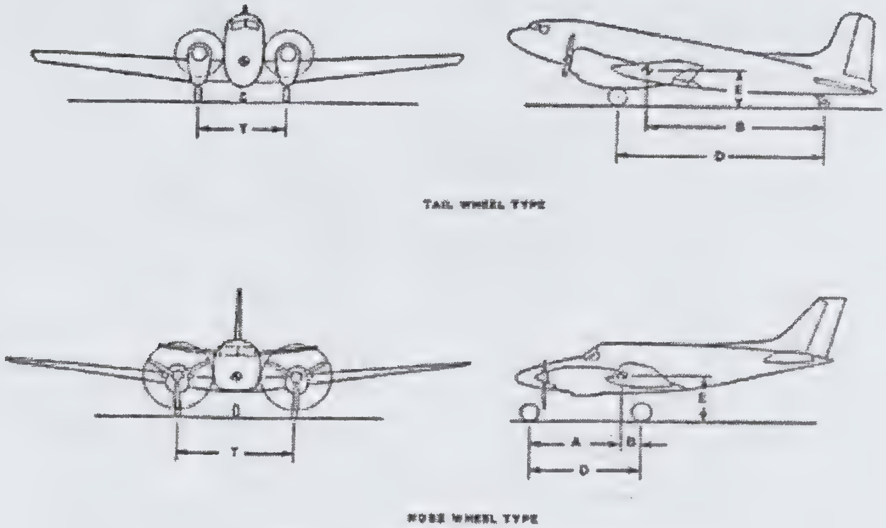


FIGURE 1 - Basic landing gear dimension data

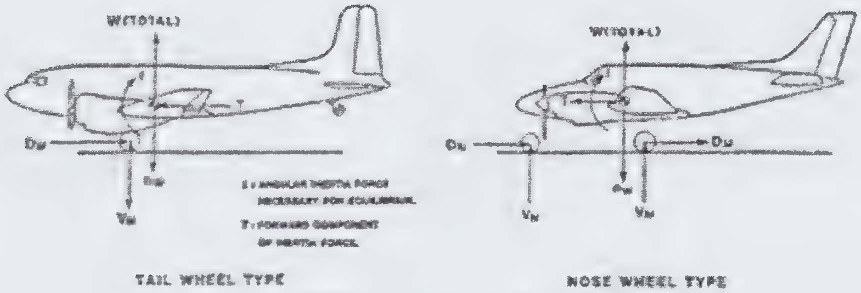


FIGURE 2 - Level landing

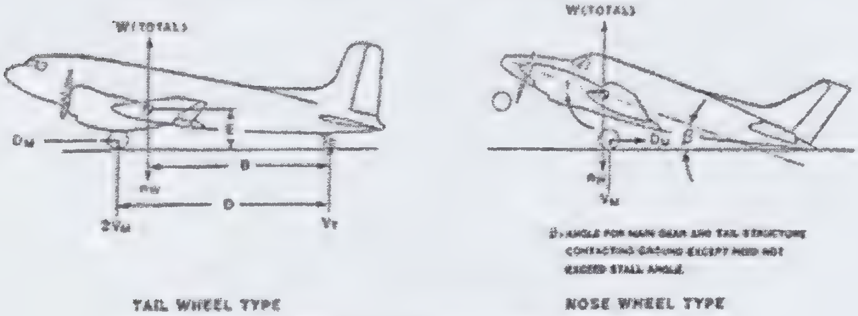
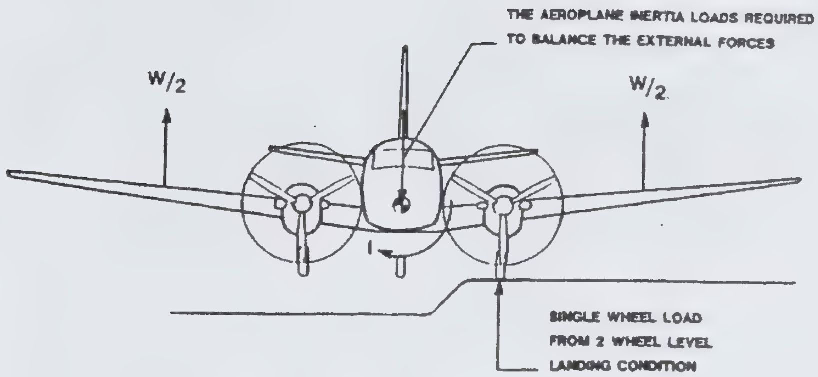
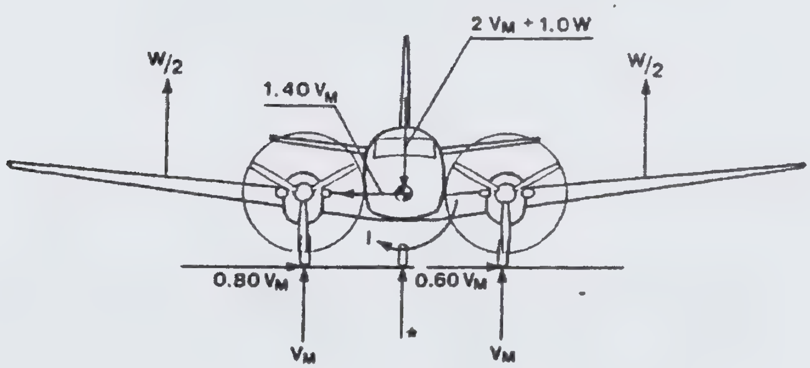


FIGURE 3 - Tail down landing



NOSE OR TAIL WHEEL TYPE

FIGURE 4 - One wheel landing



V_M : ONE-HALF THE MAXIMUM VERTICAL GROUND REACTION OBTAINED AT EACH MAIN GEAR IN THE LEVEL LANDING CONDITIONS.

*NOSE GEAR GROUND REACTION = 0

NOSE OR TAIL WHEEL TYPE AEROPLANE IN LEVEL ATTITUDE

FIGURE 5 - Lateral drift landing

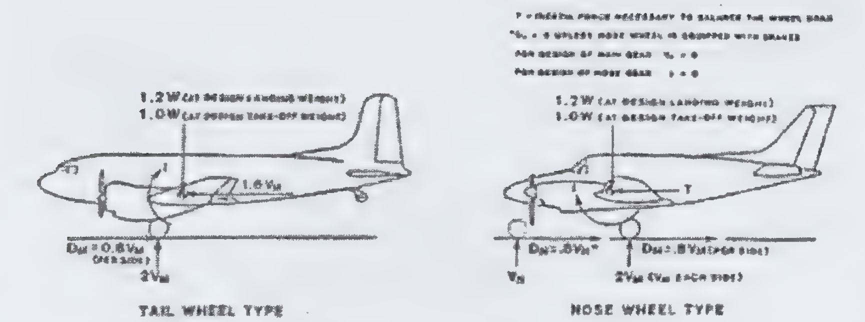


FIGURE 6 - Braked roll

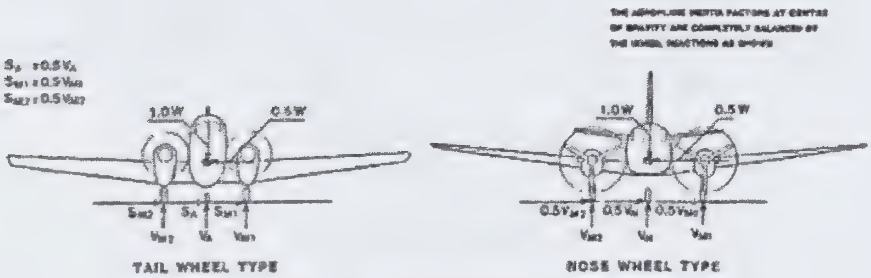
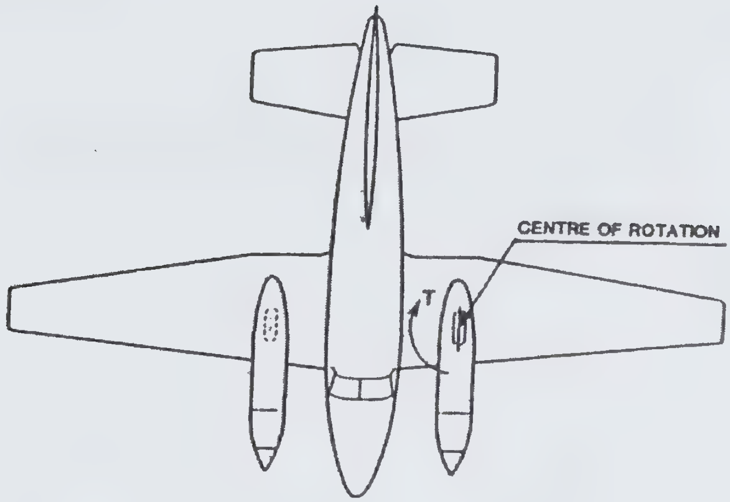


FIGURE 7 - Ground turning



V_N AND V_M ARE STATIC GROUND REACTIONS. FOR TAIL WHEEL TYPE, THE AEROPLANE IS IN THE THREE POINT ATTITUDE. PIVOTING IS ASSUMED TO TAKE PLACE ABOUT ONE MAIN LANDING GEAR UNIT.

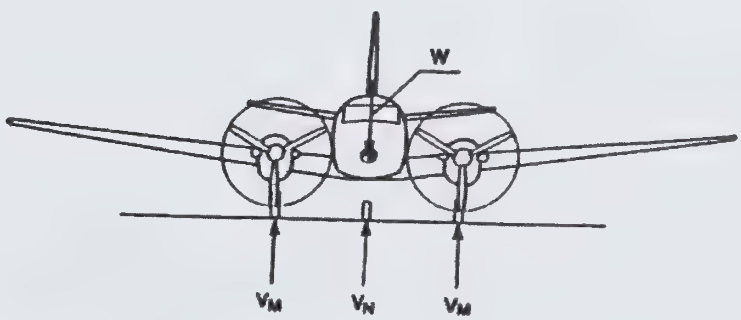


FIGURE 8 - Pivoting, nose or tail wheel type

APPENDIX B

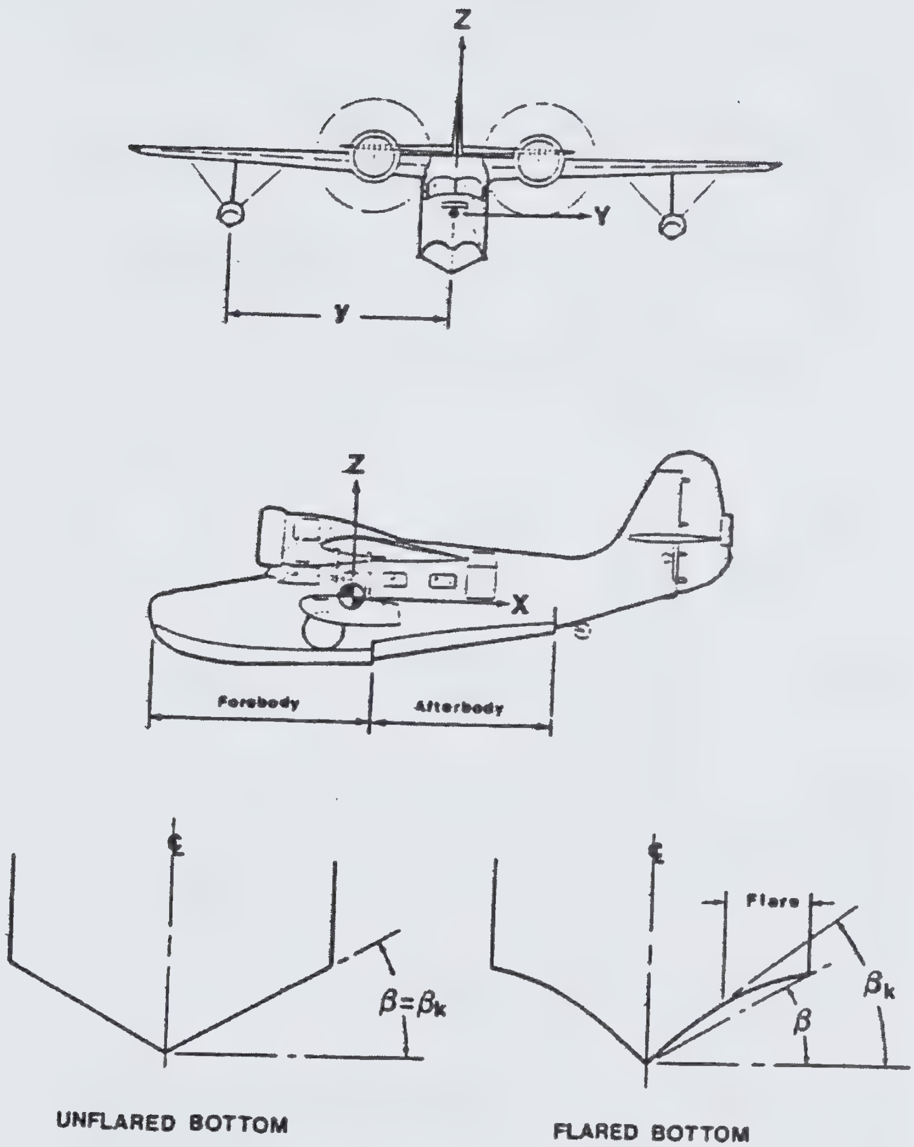


FIGURE 1 - Pictorial definitions of angles, dimensions and directions on a seaplane.

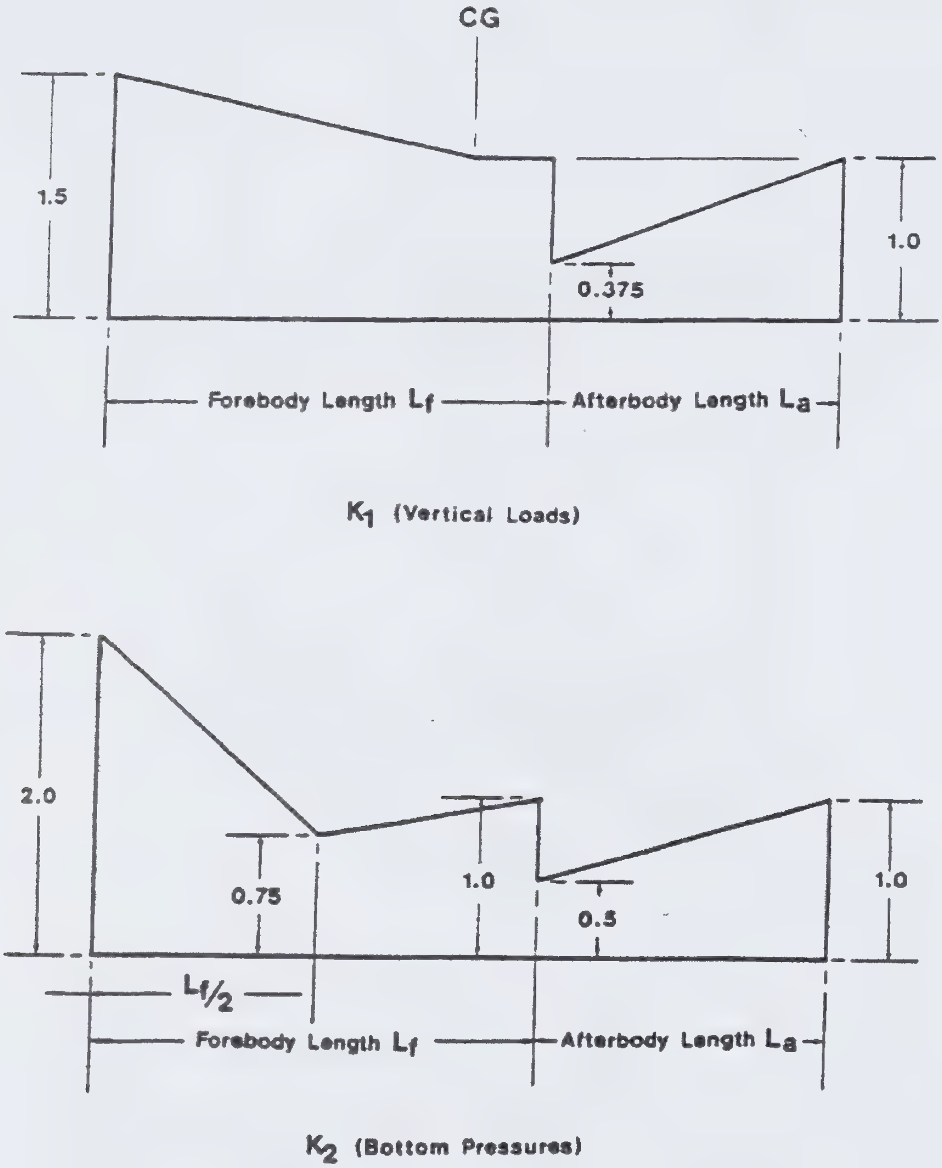


FIGURE 2 - Hull station weighing factor

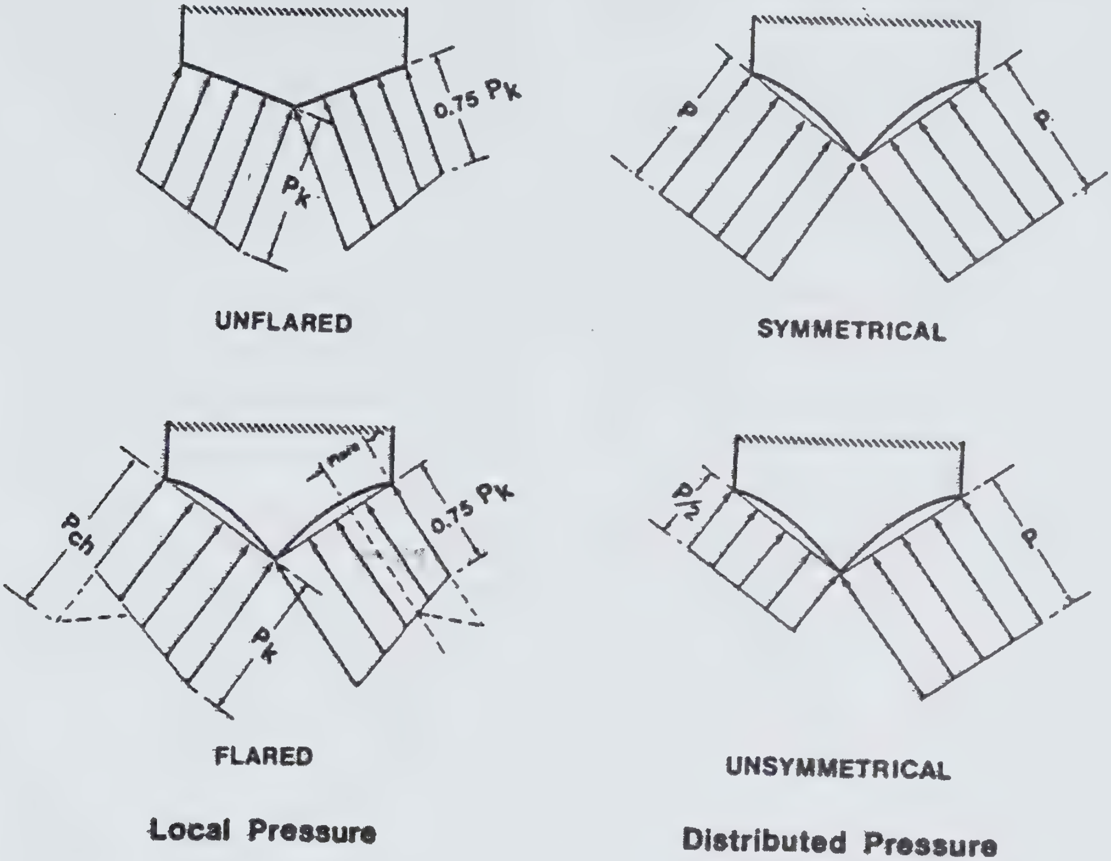


FIGURE 3 - Transverse pressure distributions

APPENDIX C

Part I – Atmospheric Icing Conditions
(amended 2008/10/30)

(a) Continuous maximum icing. The maximum continuous intensity of atmospheric icing conditions (continuous maximum icing) is defined by the variables of the cloud liquid water content, the mean effective diameter of the cloud droplets, the ambient air temperature, and the interrelationship of these three variables as shown in Figure 1 of this Appendix. The limiting icing envelope in terms of altitude and temperature is given in Figure 2 of this Appendix. The inter-relationship of cloud liquid water content with drop diameter and altitude is determined from Figures 1 and 2. The cloud liquid water content for continuous maximum icing conditions of a horizontal extent, other than 17.4 nautical miles (32.225 km), is determined by the value of liquid water content of Figure 1, multiplied by the appropriate factor from Figure 3 of this Appendix.
(amended 2008/10/30)

(b) Intermittent maximum icing. The intermittent maximum intensity of atmospheric icing conditions (intermittent maximum icing) is defined by the variables of the cloud liquid water content, the mean effective diameter of the cloud droplets, the ambient air temperature, and the inter-relationship of these three variables as shown in Figure 4 of this Appendix. The limiting icing envelope in terms of altitude and temperature is given in Figure 5 of this Appendix. The inter-relationship of cloud liquid water content with drop diameter and altitude is determined from Figures 4 and 5. The cloud liquid water content for intermittent maximum icing conditions of a horizontal extent, other than 2.6 nautical miles (4.815 km), is determined by the value of cloud liquid water content of Figure 4 multiplied by the appropriate factor in Figure 6 of this Appendix.
(amended 2008/10/30)

(c) Take-off maximum icing. The maximum intensity of atmospheric icing conditions for take-off (take-off maximum icing) is defined by the cloud liquid water content of 0.35 g/m^3, the mean effective diameter of the cloud droplets of 20 microns, and the ambient air temperature at ground level of minus 9 degrees Celsius (-9° C). The take-off maximum icing conditions extend from ground level to a height of 1,500 feet above the level of the take-off surface.
(amended 2008/10/30)

Part II - Airframe Ice Accretions for Showing Compliance with Subchapter B
(amended 2008/10/30)

(a) Ice accretions - General. The most critical ice accretion in terms of aeroplane performance and handling qualities for each flight phase shall be used to show compliance with the applicable aeroplane performance and handling requirements in icing conditions of subchapter B of this chapter. Applicants shall demonstrate that the full range of atmospheric icing conditions specified in Part I of this Appendix have been considered, including the mean effective diameter of the cloud droplets, liquid water content, and temperature appropriate to the flight conditions (for example, configuration, speed, angle-of-attack, and altitude). The ice accretions for each flight phase are defined as follows:
(amended 2008/10/30)

(1) Take-off ice is the most critical ice accretion on unprotected surfaces and any ice accretion on the protected surfaces appropriate to normal ice protection system operation, occurring between lift-off and 400 feet above the take-off surface, assuming accretion starts at lift-off in the take-off maximum icing conditions of part I, paragraph (c) of this Appendix.
(amended 2008/10/30)

(2) Final take-off ice is the most critical ice accretion on unprotected surfaces and any ice accretion on the protected surfaces appropriate to normal ice protection system operation, between 400 feet and either 1,500 feet above the take-off surface, or the height at which the transition from the take-off to the en route configuration is completed and V_{FTO} is reached, whichever is higher. Ice accretion is assumed to start at lift-off in the take-off maximum icing conditions of part I, paragraph (c) of this Appendix.
(amended 2008/10/30)

(3) En route ice is the critical ice accretion on unprotected surfaces and any ice accretion on the protected surfaces appropriate to normal ice protection system operation, during the en route phase.
(amended 2008/10/30)

(4) Holding ice is the critical ice accretion on unprotected surfaces and any ice accretion on the protected surfaces appropriate to normal ice protection system operation, during the holding flight phase.
(amended 2008/10/30)

(5) Approach ice is the critical ice accretion on unprotected surfaces and any ice accretion on the protected surfaces appropriate to normal ice protection system operation following exit from the holding flight phase and transition to the most critical approach configuration.
(amended 2008/10/30)

(6) Landing ice is the critical ice accretion on unprotected surfaces and any ice accretion on the protected surfaces appropriate to normal ice protection system operation following exit from the approach flight phase and transition to the final landing configuration.
(amended 2008/10/30)

(b) In order to reduce the number of ice accretions to be considered when demonstrating compliance with the requirements of 525.21(g), any of the ice accretions defined in paragraph (a) of this section may be used for any other flight phase if it is shown to be more critical than the specific ice accretion defined for that flight phase. Configuration differences and their effects on ice accretions shall be taken into account.
(amended 2008/10/30)

(c) The ice accretion that has the most adverse effect on handling qualities may be used for aeroplane performance tests provided any difference in performance is conservatively taken into account.
(amended 2008/10/30)

(d) For both unprotected and protected parts, the ice accretion for the take-off phase may be determined by calculation, assuming the take-off maximum icing conditions defined in Appendix C, and assuming that:
(amended 2008/10/30)

(1) Airfoils, control surfaces and, if applicable, propellers are free from frost, snow or ice at the start of the take-off;
(amended 2008/10/30)

(2) The ice accretion starts at lift-off;
(amended 2008/10/30)

(3) The critical ratio of thrust/power-to-weight is used;
(amended 2008/10/30)

(4) Failure of the critical engine occurs at V_{EF}; and
(amended 2008/10/30)

(5) Flight crew activation of the ice protection system is in accordance with a normal operating procedure provided in the *Aeroplane Flight Manual*, except that after beginning the take-off roll, it shall be assumed that the flight crew takes no action to activate the ice protection system until the aeroplane is at least 400 feet above the take-off surface.
(amended 2008/10/30)

(e) The ice accretion before the ice protection system has been activated and is performing its intended function is the critical ice accretion formed on the unprotected and normally protected surfaces before activation and effective operation of the ice protection system in continuous maximum atmospheric icing conditions. This ice accretion only applies in showing compliance to 525.143(j) and 525.207(h).
(amended 2008/10/30)

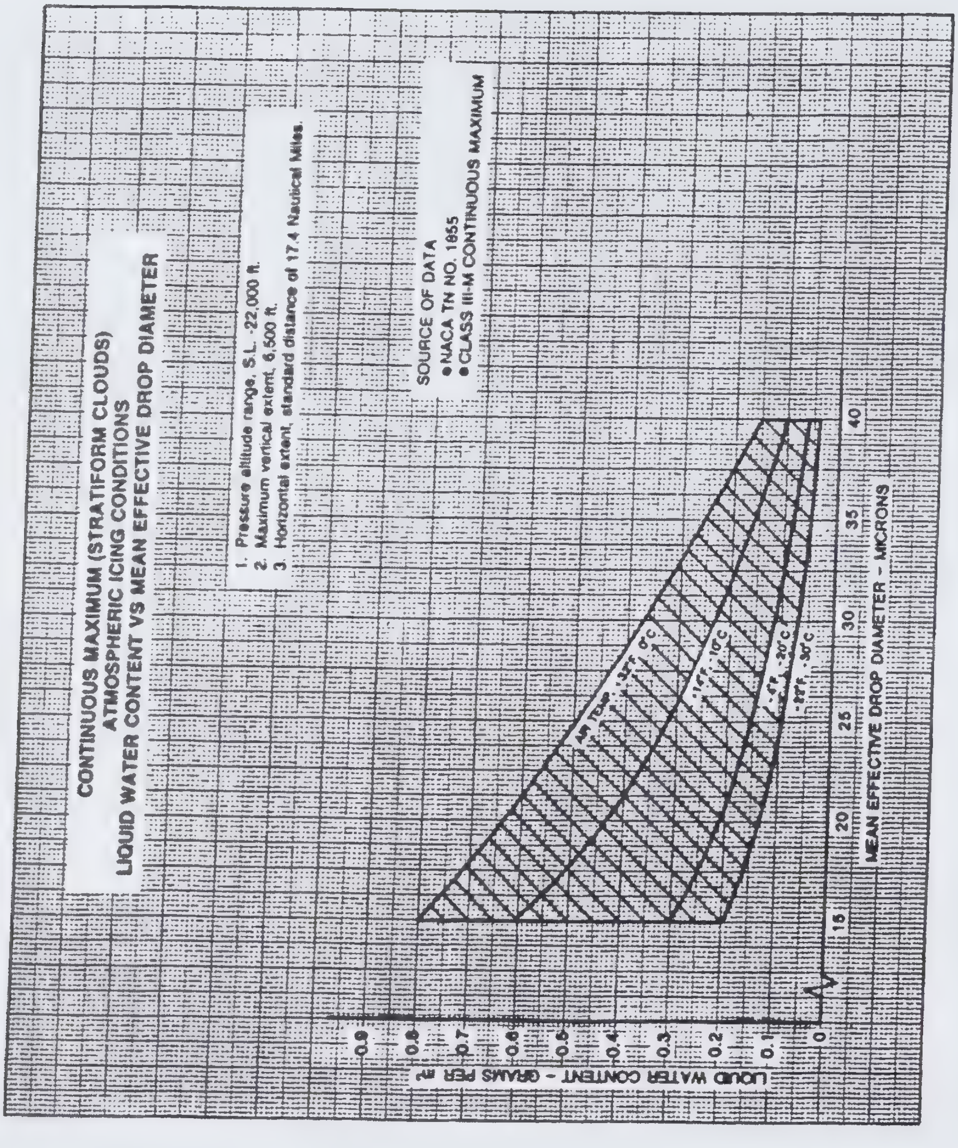

CONTINUOUS MAXIMUM (STRATIFORM CLOUDS)
ATMOSPHERIC ICING CONDITIONS
LIQUID WATER CONTENT VS MEAN EFFECTIVE DROP DIAMETER
1. Pressure altitude range, S.L. -22,000 ft.
2. Maximum vertical extent, 6,500 ft.
3. Horizontal extent, standard distance of 17.4 Nautical Miles.
SOURCE OF DATA
● NACA TN NO. 1855
● CLASS III-M CONTINUOUS MAXIMUM
AIR TEMP. 32°F, 0°C
14°F, -10°C
-4°F, -20°C
-22°F, -30°C
LIQUID WATER CONTENT - GRAMS PER m³
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
MEAN EFFECTIVE DROP DIAMETER - MICRONS
15
20
25
30
35
40

FIGURE 1

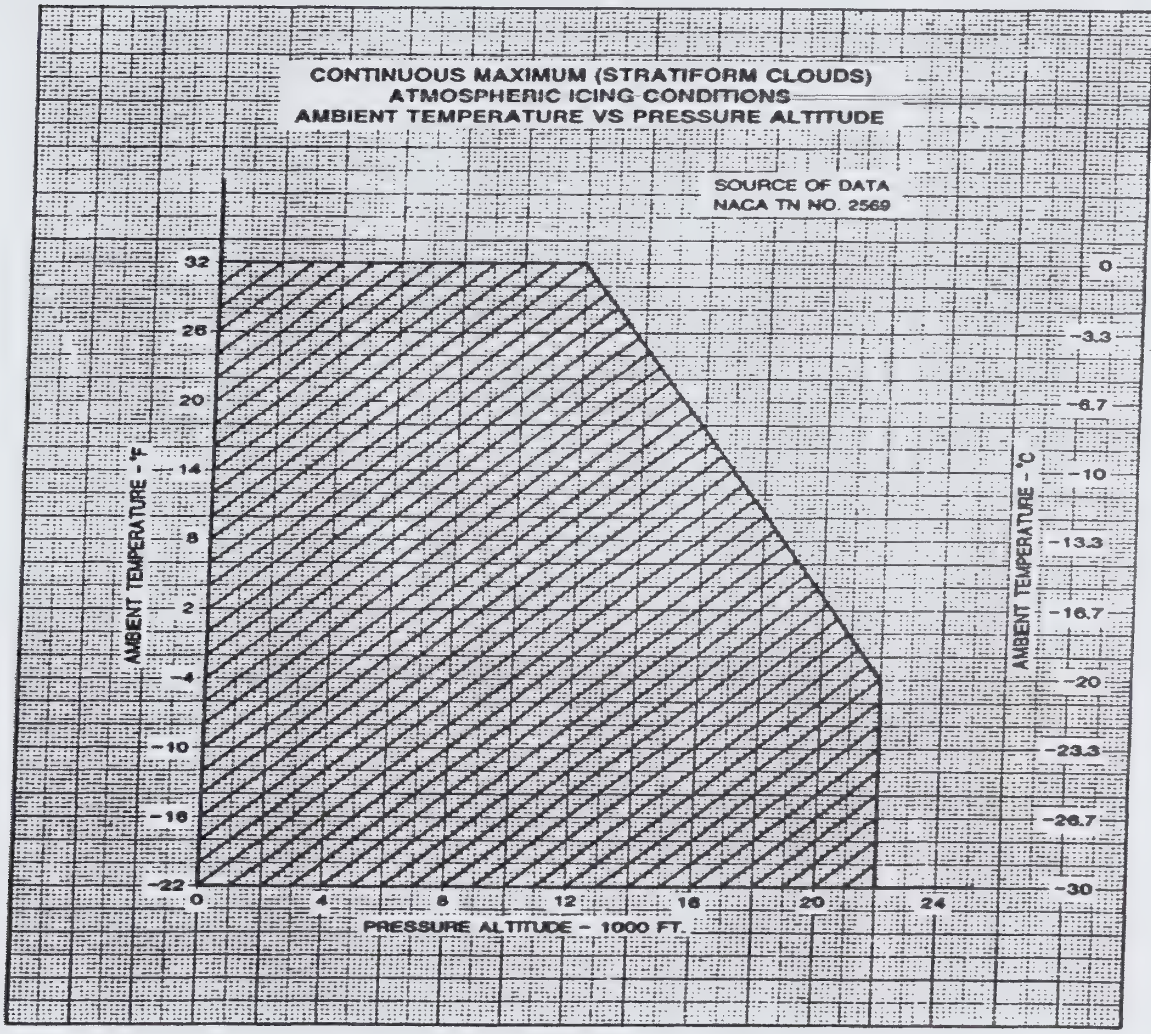

CONTINUOUS MAXIMUM (STRATIFORM CLOUDS)
ATMOSPHERIC ICING CONDITIONS
AMBIENT TEMPERATURE VS PRESSURE ALTITUDE
SOURCE OF DATA
NACA TN NO. 2569
AMBIENT TEMPERATURE - °F
32
26
20
14
8
2
-4
-10
-16
-22
AMBIENT TEMPERATURE - °C
0
-3.3
-6.7
-10
-13.3
-16.7
-20
-23.3
-26.7
-30
0
4
8
12
16
20
24
PRESSURE ALTITUDE - 1000 FT.

FIGURE 2

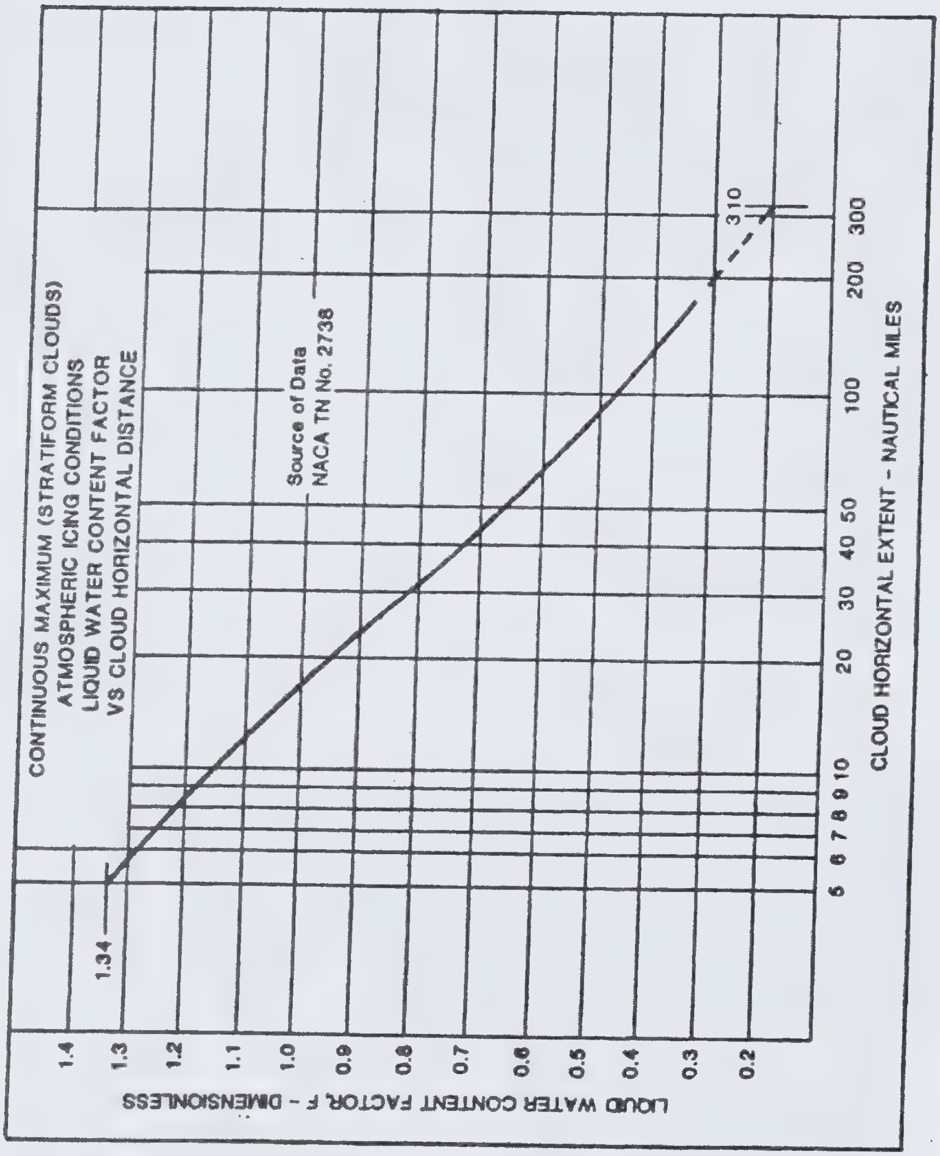

CONTINUOUS MAXIMUM (STRATIFORM CLOUDS)
ATMOSPHERIC ICING CONDITIONS
LIQUID WATER CONTENT FACTOR
VS CLOUD HORIZONTAL DISTANCE
Source of Data
NACA TN No. 2738
1.34
310
LIQUID WATER CONTENT FACTOR, F - DIMENSIONLESS
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
5 6 7 8 9 10
20
30
40 50
100
200
300
CLOUD HORIZONTAL EXTENT - NAUTICAL MILES

FIGURE 3

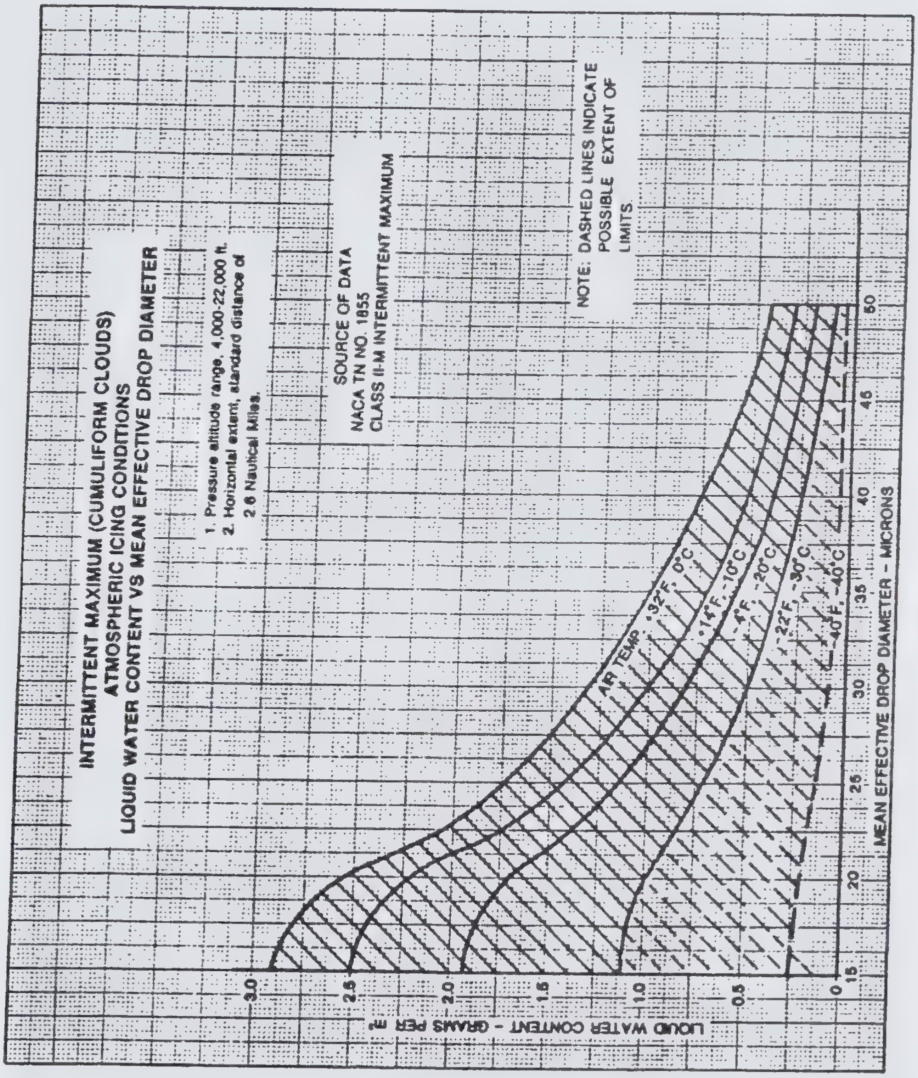

INTERMITTENT MAXIMUM (CUMULIFORM CLOUDS)
ATMOSPHERIC ICING CONDITIONS
LIQUID WATER CONTENT VS MEAN EFFECTIVE DROP DIAMETER
1. Pressure altitude range, 4,000-22,000 ft.
2. Horizontal extent, standard distance of 2.6 Nautical Miles.
SOURCE OF DATA
NACA TN NO. 1855
CLASS II-M INTERMITTENT MAXIMUM
NOTE: DASHED LINES INDICATE POSSIBLE EXTENT OF LIMITS.
AIR TEMP. +32°F, 0°C
+14°F, -10°C
-4°F, -20°C
-22°F, -30°C
-40°F, -40°C
LIQUID WATER CONTENT - GRAMS PER M³
3.0
2.5
2.0
1.5
1.0
0.5
0
MEAN EFFECTIVE DROP DIAMETER - MICRONS
15
20
25
30
35
40
45
50

FIGURE 4

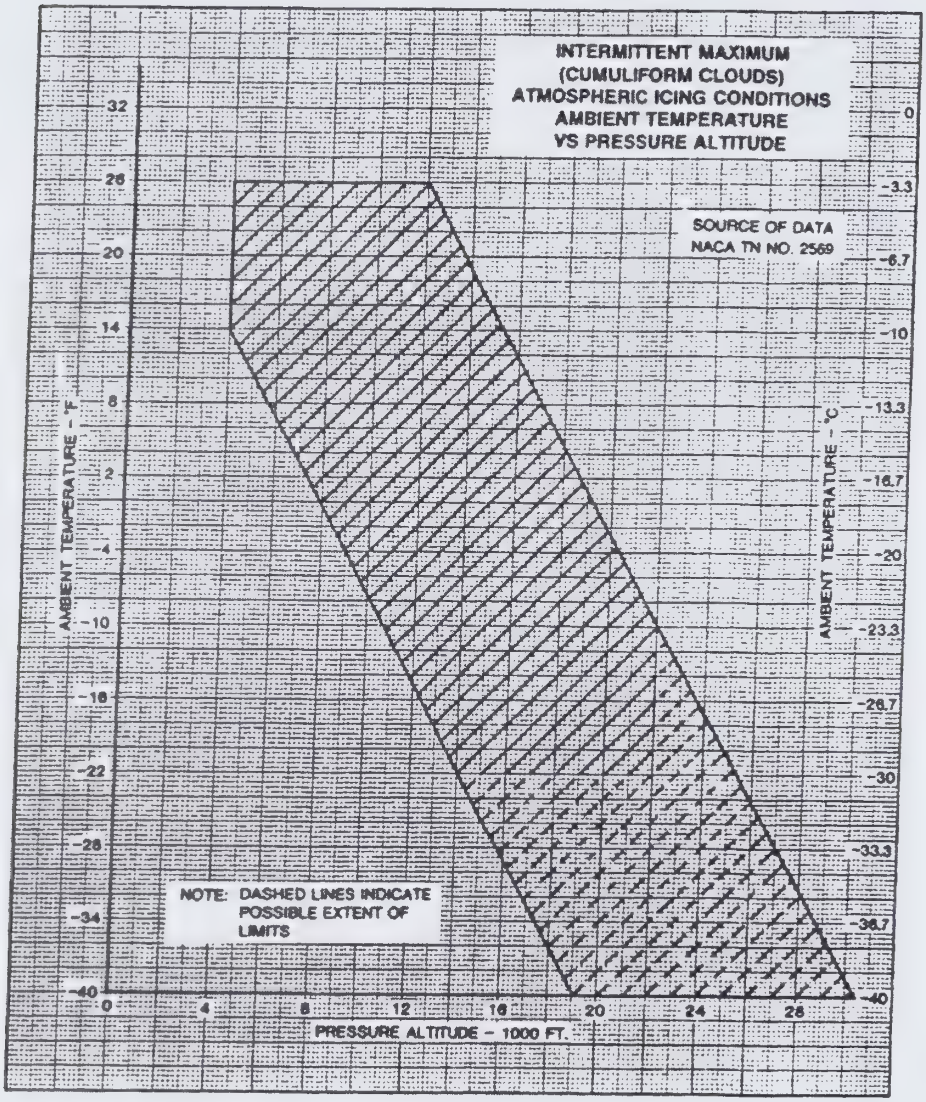

INTERMITTENT MAXIMUM
(CUMULIFORM CLOUDS)
ATMOSPHERIC ICING CONDITIONS
AMBIENT TEMPERATURE
VS PRESSURE ALTITUDE
SOURCE OF DATA
NACA TN NO. 2569
NOTE: DASHED LINES INDICATE
POSSIBLE EXTENT OF
LIMITS
AMBIENT TEMPERATURE - °F
AMBIENT TEMPERATURE - °C
PRESSURE ALTITUDE - 1000 FT.
32
26
20
14
8
2
-4
-10
-16
-22
-28
-34
-40
0
-3.3
-6.7
-10
-13.3
-16.7
-20
-23.3
-26.7
-30
-33.3
-36.7
-40
0
4
8
12
16
20
24
28

FIGURE 5

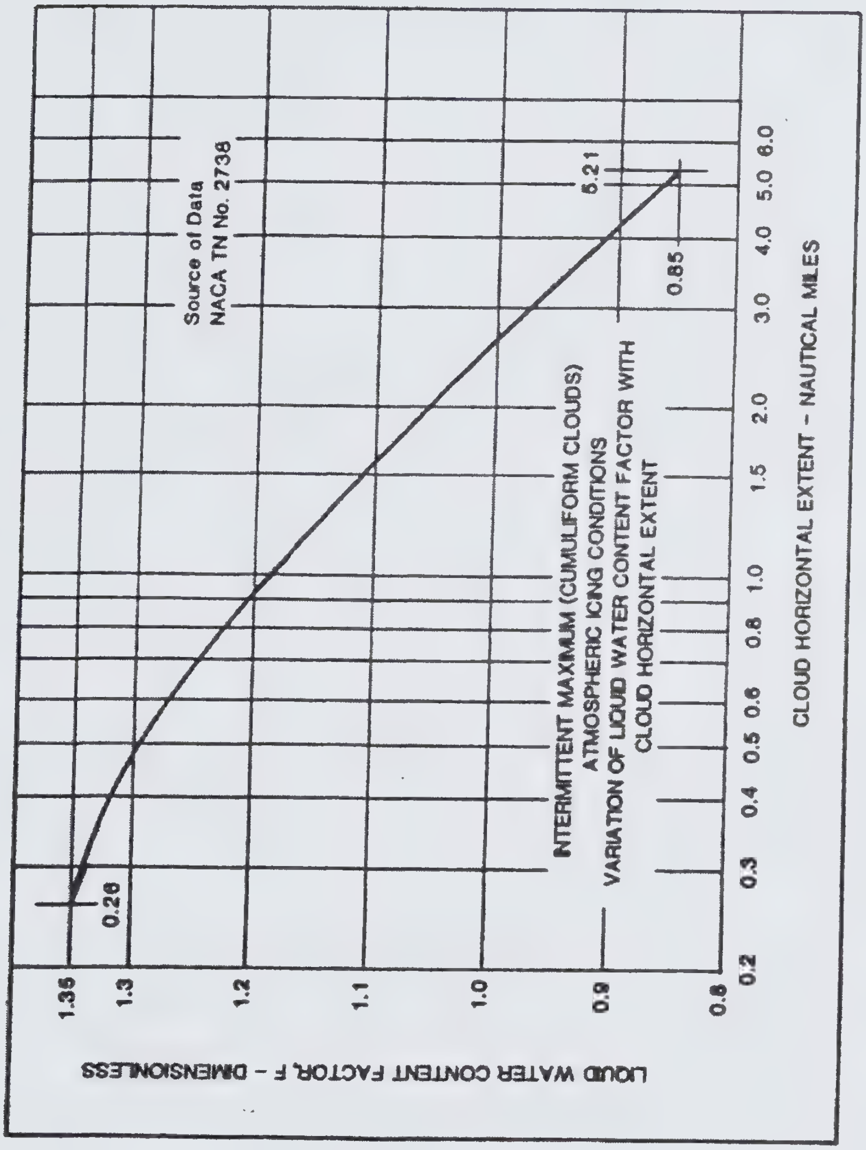

Source of Data
NACA TN No. 2738
INTERMITTENT MAXIMUM (CUMULIFORM CLOUDS)
ATMOSPHERIC ICING CONDITIONS
VARIATION OF LIQUID WATER CONTENT FACTOR WITH
CLOUD HORIZONTAL EXTENT
LIQUID WATER CONTENT FACTOR, F – DIMENSIONLESS
CLOUD HORIZONTAL EXTENT – NAUTICAL MILES
1.35
1.3
1.2
1.1
1.0
0.9
0.8
0.2
0.3
0.4
0.5
0.6
0.8
1.0
1.5
2.0
3.0
4.0
5.0
6.0
0.26
5.21
0.85

FIGURE 6

APPENDIX D

Criteria for determining minimum flight crew. The following are considered by the Minister in determining the minimum flight crew under 525.1523:

(a) Basic workload functions. The following basic workload functions are considered:

(1) Flight path control;

(2) Collision avoidance;

(3) Navigation;

(4) Communications;

(5) Operation and monitoring of aircraft engines and systems;

(6) Command decisions.

(b) Workload factors. The following workload factors are considered significant when analysing and demonstrating workload for minimum flight crew determination:

(1) The accessibility, ease, and simplicity of operation of all necessary flight, power, and equipment controls, including emergency fuel shutoff valves, electrical controls, electronic controls, pressurisation system controls, and engine controls.

(2) The accessibility and conspicuity of all necessary instruments and failure warning devices such as fire warning, electrical system malfunction, and other failure or caution indicators. The extent to which such instruments or devices direct the proper corrective action is also considered.

(3) The number, urgency, and complexity of operating procedures with particular consideration given to the specific fuel management schedule imposed by centre of gravity, structural or other considerations of an airworthiness nature, and to the ability of each engine to operate at all times from a single tank or source which is automatically replenished if fuel is also stored in other tanks.

(4) The degree and duration of concentrated mental and physical effort involved in normal operation and in diagnosing and coping with malfunctions and emergencies.

(5) The extent of required monitoring of the fuel, hydraulic, pressurisation, electrical, electronic, de-icing, and other systems while en route.

(6) The actions requiring a crewmember to be unavailable at his assigned duty station, including: observation of systems, emergency operation of any control, and emergencies in any compartment.

(7) The degree of automation provided in the aircraft systems to afford (after failures or malfunctions) automatic crossover or isolation of difficulties to minimise the need for flight crew action to guard against loss of hydraulic or electric power to flight controls or to other essential systems.

(8) The communications and navigation workload.

(9) The possibility of increased workload associated with any emergency that may lead to other emergencies.

(10) Incapacitation of a flight crew member whenever the applicable operating rule requires a minimum flight crew of at least two pilots.

(c) Kind of operation authorised. The determination of the kind of operation authorised requires consideration of the operating rules under which the aeroplane will be operated. Unless an applicant desires approval for a more limited kind of operation, it is assumed that each aeroplane certificated under this Chapter will operate under IFR conditions.

APPENDIX E

Part I Limited Weight Credit For Aeroplanes Equipped With Standby Power

(a) Each applicant for an increase in the maximum certificated take-off and landing weights of an aeroplane equipped with a type certificated standby power rocket engine may obtain an increase as specified in paragraph *(b)* if:

(1) The installation of the rocket engine has been approved and it has been established by flight test that the rocket engine and its controls can be operated safely and reliably at the increase in maximum weight; and

(2) The *Aeroplane Flight Manual*, or the placard, markings or manuals required in place thereof, set forth in addition to any other operating limitations the Minister may require, the increased weight approved under this regulation and a prohibition against the operation of the aeroplane at the approved increased weight when:

(i) The installed standby power rocket engines have been stored or installed in excess of the time limit established by the manufacturer of the rocket engine (usually stencilled on the engine casing); or

(ii) The rocket engine fuel has been expended or discharged.

(b) The currently approved maximum take-off and landing weights at which an aeroplane is certificated without a standby power rocket engine installation may be increased by an amount that does not exceed any of the following:

(1) An amount equal in pounds to 0.014 IN, where I is the maximum usable impulse in pounds-seconds available from each standby power rocket engine and N is the number of rocket engines installed.

(2) An amount equal to 5 percent of the maximum certificated weight approved in accordance with the applicable airworthiness regulations without standby power rocket engines installed.

(3) An amount equal to the weight of the rocket engine installation.

(4) An amount that, together with the currently approved maximum weight, would equal the maximum structural weight established for the aeroplane without standby rocket engines installed.

Part II Performance Credit for Transport Category Aeroplanes Equipped With Standby Power

The Minister may grant performance credit for the use of standby power on transport category aeroplanes. However, the performance credit applies only to the maximum certificated take-off and landing weights, the take-off distance, and the take-off paths, and may not exceed that found by the Minister to result in an overall level of safety in the take-off, approach, and landing regimes of flight equivalent to that prescribed in the regulations under which the aeroplane was originally certificated without standby power. For the purposes of this Appendix, "standby power" is power or thrust, or both, obtained from rocket engines for a

relatively short period and actuated only in cases of emergency. The following provisions apply:

(a) Take-off; General. The take-off data prescribed in *(b)* and *(c)* (below) must be determined at all weights and altitudes, and at ambient temperatures if applicable, at which performance credit is to be applied.

(b) Take-off path.

(1) The one-engine-inoperative take-off path with standby power in use must be determined in accordance with the performance requirements of the applicable airworthiness regulations.

(2) The one-engine-inoperative take-off path (excluding that part where the aeroplane is on or just above the take-off surface) determined in accordance with paragraph (1) of this section must lie above the one-engine-inoperative take-off path without standby power at the maximum take-off weight at which all of the applicable airworthiness requirements are met. For the purpose of this comparison, the flight path is considered to extend to at least a height of 400 feet above the take-off surface.

(3) The take-off path with all engines operating but without the use of standby power, must reflect a conservatively greater overall level of performance than the one-engine-inoperative take-off path established in accordance with paragraph (1) of this section. The margin must be established by the Minister to insure safe day-to-day operations, but in no case may it be less than 15 percent. The all-engines-operating take-off path must be determined by a procedure consistent with that established in complying with paragraph (1) of this section.

(4) For reciprocating-engine powered aeroplanes, the take-off path to be scheduled in the *Aeroplane Flight Manual* must represent the one-engine-inoperative take-off path determined in accordance with paragraph (1) of this section and modified to reflect the procedure (see Section (f)) established by the applicant for flap retraction and attainment of the en route speed. The scheduled take-off path must have a positive slope at all points of the airborne portion and at no point must it lie above the take-off path specified in paragraph (1) of this section.

(c) Take-off distance. The take-off distance must be the horizontal distance along the one-engine-inoperative take-off path determined in accordance with paragraph *(b)*(1) from the start of the take-off to the point where the aeroplane attains a height of 50 feet above the take-off surface for reciprocating-engine powered aeroplanes and a height of 35 feet above the take-off surface for turbine-powered aeroplanes.

(d) Maximum certificated take-off weights. The maximum certificated take-off weights must be determined at all altitudes, and at ambient temperatures, if applicable, at which performance credit is to be applied and may not exceed the weights established in compliance with paragraphs *(d)*(1) and (2) of this section.

(1) The conditions of (b)(2) through (4) must be met at the maximum certificated take-off weight.

(2) Without the use of standby power, the aeroplane must meet all of the en route requirements of the applicable airworthiness regulations under which the aeroplane was originally certificated. In addition, turbine-powered aeroplanes without the use of standby power must meet the final take-off climb requirements prescribed in the applicable airworthiness regulations.

(e) Maximum certificated landing weights.

(1) The maximum certificated landing weights (one-engine-inoperative approach and all-engines-operating landing climb) must be determined at all altitudes, and at ambient temperatures if applicable, at which performance credit is to be applied and must not exceed that established in compliance with paragraph (2) of this section.

(2) The flight path, with the engines operating at the power or thrust, or both, appropriate to the aeroplane configuration and with standby power in use, must lie above the flight path without standby power in use at the maximum weight at which all of the applicable airworthiness requirements are met. In addition, the flight paths must comply with subparagraphs (i) and (ii) of this paragraph.

(i) The flight paths must be established without changing the appropriate aeroplane configuration.

(ii) The flight paths must be carried out for a minimum height of 400 feet above the point where standby power is actuated.

(f) Aeroplane configuration, speed, and power and thrust; general. Any change in the aeroplane's configuration, speed, and power or thrust, or both, must be made in accordance with the procedures established by the applicant for the operation of the aeroplane in service and must comply with paragraphs (1) through (3) of this section. In addition, procedures must be established for the execution of balked landings and missed approaches.

(1) The Minister must find that the procedure can be consistently executed in service by crews of average skill.

(2) The procedure may not involve methods or the use of devices which have not been proven to be safe and reliable.

(3) Allowances must be made for such time delays in the execution of the procedures as may be reasonably expected to occur during service.

(g) Installation and operation; standby power. The standby power unit and its installation must comply with paragraphs (1) and (2) of this section.

(1) The standby power unit and its installation must not adversely affect the safety of the aeroplane.

(2) The operation of the standby power unit and its control must have proven to be safe and reliable.

APPENDIX F

Part I Test Criteria Procedure for Showing Compliance with 525.853, or 525.855

(a) Material test criteria:

(1) Interior compartments occupied by crew or passengers.

(i) Interior ceiling panels, interior wall panels, partitions, galley structure, large cabinet walls, structural flooring, and materials used in the construction of stowage compartments (other than underseat stowage compartments and compartments for stowing small items such as magazines and maps) must be self-extinguishing when tested vertically in accordance with the applicable portions of Part I of this Appendix. The average burn length may not exceed 6 inches and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 3 seconds after falling.

(ii) Floor covering, textiles (including draperies and upholstery), seat cushions, padding, decorative and non-decorative coated fabrics, leather, trays and galley furnishings, electrical conduit, air ducting, joint and edge covering, liners of Class B and E cargo or baggage compartments, floor panels of Class B, C, D, or E cargo or baggage compartments, cargo covers and transparencies, moulded and thermoformed parts, air ducting joints, and trim strips (decorative and chafing), that are constructed of materials not covered in sub-paragraph (iv) below, shall be self-extinguishing when tested vertically in accordance with the applicable portions of Part I of this Appendix or other approved equivalent means. The average burn length may not exceed 8 inches, and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 5 seconds after falling. (amended 2004/06/08)

(iii) Motion picture film must be safety film meeting the Standard Specifications for Safety Photographic Film PHI.25 (available from the American National Standards Institute, 1430 Broadway, New York, NY 10018). If the film travels through ducts, the ducts must meet the requirements of subparagraph (ii) of this paragraph.

(iv) Clear plastic windows and signs, parts constructed in whole or in part of elastomeric materials, edge lighted instrument assemblies consisting of two or more instruments in a common housing, seat belts, shoulder harnesses, and cargo and baggage tiedown equipment, including containers, bins, pallets, etc., used in passenger or crew compartments, may not have an average burn rate greater than 2.5 inches per minute when tested horizontally in accordance with the applicable portions of this Appendix.

(v) Except for small parts (such as knobs, handles, rollers, fasteners, clips, grommets, rub strips, pulleys, and small electrical parts) that would not contribute significantly to the propagation of a fire and for electrical wire and cable insulation, materials in items not specified in paragraphs (a)(1)(i), (ii), (iii), or (iv) of Part I of this Appendix may not have a burn rate greater than 4.0 inches per minute when tested horizontally in accordance with the applicable portions of this Appendix.

(2) Cargo and baggage compartments not occupied by crew or passengers.

(i) Removed and reserved
(amended 2004/06/08)

(ii) A cargo of baggage compartment defined in 525.657 as Class B or E must have a liner constructed of materials that meet the requirements of paragraph (a)(i)(ii) of Part I of this Appendix and separated from the aeroplane structure (except for attachments). In addition, such liners must be subjected to the 45 degree angle test. The flame may not penetrate (pass through) the material during application of the flame or subsequent to its removal. The average flame time after removal of the flame source may not exceed 15 seconds, and the average glow time may not exceed 10 seconds.

(iii) A cargo or baggage compartment defined in 525.657 and Class B, C, or E must have floor panels constructed of materials which meet the requirements of paragraph (a)(1)(ii) of Part I of this Appendix and which are separated from the aeroplane structure (except for attachments). Such panels must be subjected to the 45 degree angle test. The flame may not penetrate (pass through) the material during application of the flame or subsequent to its removal. The average flame time after removal of the flame source may not exceed 15 seconds, and the average glow time may not exceed 10 second.

(iv) Insulation blankets and covers used to protect cargo must be constructed of materials that meet the requirements of paragraph (a)(1)(ii) of Part I of this Appendix. Tiedown equipment (including containers, bins, and pallets) used in each cargo and baggage compartment must be constructed of materials that meet the requirements of paragraph (a)(1)(v) of Part I of this Appendix.

(3) *Electrical system components.* Insulation on electrical wire or cable installed in any area of the fuselage must be self-extinguishing when subjected to the 60 degree test specified in Part I of this Appendix. The average burn length may not exceed 3 inches, and the average flame time after removal of the flame source may not exceed 30 second. Drippings form the test specimen may not continue to flame for more than an average of 3 seconds. Drippings for the test specimen may not continue to flame for more than an average of 3 seconds after falling.

(b) Test Procedures:

(1) *Conditioning.* Specimens must be conditioned to 70°F, plus or minus 5°, and at 50 percent plus or minus 5 percent relative humidity until moisture equilibrium is reached or

for 24 hours. Each specimen must remain in the conditioning environment until it is subjected to the flame.

(2) *Specimen configuration.* Except for small parts and electrical wire and cable insulation, materials must be tested either as a section cut from a fabricated part as installed in the aeroplane or as a specimen simulating a cut section, such as a specimen cut from a flat sheet of the material or a model of the fabricated part. The specimen

may be cut from any location in a fabricated part; however, fabricated units, such as sandwich panels, may not be separated for test. Except as noted below, the specimen thickness must be no thicker than the minimum thickness to be qualified for use in the aeroplane. Test specimens of thick foam parts, such as seat cushions, must be tested in 1/2-inch thickness. Test specimens of materials that must meet the requirements of paragraph (a)(1)(v) of Part I of this Appendix must be no more than 1\8 inch in thickness. Electrical wire and cable specimens must be the same size as used in the aeroplane. In the case of fabrics, both the wrap and fill direction of the weave must be tested to determine the most critical flammability condition. Specimens must be mounted in a metal frame so that the two long edges and the upper edge are held securely during the vertical test prescribed in subparagraph (4) of this paragraph and the two long edges and the edge away from the flame are held securely during the horizontal test prescribed in sub-paragraph (5) of this paragraph. The exposed area of the specimen must be at least 2 inches wide and 12 inches long, unless the actual size used in the aeroplane is smaller. The edge to which the burner flame is applied must not consist of the finished or protected edge of the specimen but must be representative of the actual cross-section of the material or part as installed in the aeroplane. The specimen must be mounted in a metal frame so that all four edges are held securely and the exposed area of the specimen is at least 8 inches by 8 inches during the 45° test prescribed in subparagraph (6) of this paragraph.

(3) *Apparatus.* Except as provided in subparagraph (7) of this paragraph, tests must be conducted in a draft-free cabinet in accordance with Federal Test Method Standard 191 Method 5903 (revised Method 5902) for the vertical test, or Method 5906 for horizontal test (available from the General Services Administration, Business Service Centre, Region 3, Seventh & D Streets, S.W., Washington, D.C. 20407). Specimens which are too large for the cabinet must be tested in similar draft-free conditions.

(4) *Vertical test.* A minimum of three specimens must be tested and the results averaged. For fabrics, the direction of weave corresponding to the most critical flammability conditions must be parallel to the longest dimension. Each specimen must be supported vertically. The specimen must be exposed to a Bunsen or Tirrill burner with a nominal 3/8-inch I.D. tube adjusted to give a flame of 1 ½ inches in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the centre of the flame must be 1550°F. The lower edge of the specimen must be three-fourths inch above the top edge of the burner. The flame must be applied to the centre line of the lower edge of the specimen. For materials covered by paragraph (a)(1)(i) of Part I of this Appendix, the flame must be applied for 60 seconds and then removed. For materials covered by paragraph (a)(1)(ii) of Part I of this Appendix, the flame must be applied for 12 seconds and then removed. Flame time, burn length and flaming time of drippings, if any, must be recorded.

The burn length determined in accordance with subparagraph (7) of this paragraph must be measured to the nearest tenth of an inch.

(5) *Horizontal test.* A minimum of three specimens must be tested and the results averaged. Each specimen must be supported horizontally. The exposed surface when installed in the aircraft must be face down for the test. The specimen must be exposed to a Bunsen burner or Tirrill burner with a nominal three-eights inch I.D. tube adjusted to give a flame of 1 ½ inches in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the centre of the flame must be 1550° F. The specimen must be positioned so that the edge being tested is three-fourths of an inch above the top of the burner. The flame must be applied for 15 seconds and then removed. A minimum of 10 inches of the specimen must be used for timing purposes, approximately 11/2 inches must burn before the burning front reaches the timing zone, and the average burn rate must be recorded.

(6) *Forty-five degree test.* A minimum of three specimens must be tested and the results averaged. The specimens must be supported at an angle of 45° to a horizontal surface. The exposed surface when installed in the aircraft must be face down for the test. The specimens must be exposed to a Bunsen or Tirrill burner with a nominal three-eights inch I.D. tube adjusted to give a flame of 11/2 inches in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the centre of the flame must be 1550°F. Suitable precautions must be taken to avoid drafts. The flame must be applied for 30 seconds with one-third contacting the material at the centre of the specimen and then removed. Flame time, glow time, and whether the flame penetrates (passes through) the specimen must be recorded.

(7) *Sixty degree test.* A minimum of three specimens of each wire specification (make and size) must be tested. The specimen of wire or cable (including insulation) must be placed at an angle of 60° with the horizontal in the cabinet specified in subparagraph (3) of this paragraph with the cabinet door open during the test, or must be placed within a chamber approximately 2 feet high x 1 foot x 1 foot, open at the top and at one vertical side (front), and which allows sufficient flow of air for complete combustion, but which is free from drafts. The specimen must be parallel to and approximately 6 inches from the front of the chamber. The lower end of the specimen must be held rigidly clamped. The upper end of the specimen must pass over a pulley or rod and must have an appropriate weight attached to it so that the specimen is held tautly throughout the flammability test. The test specimen span between lower clamp and upper pulley or rod must be 24 inches and must be marked 8 inches from the lower end to indicate the central point for flame application. A flame from a Bunsen or Tirrill burner must be applied for 30 seconds at the test mark. The burner must be mounted underneath the test mark on the specimen, perpendicular to the specimen and at an angle of 30° to the vertical plane of the specimen. The burner must have a nominal bore of 3/8 inch, and must be adjusted to provide a 3-inch high flame with an inner cone approximately one-third of the flame height. The minimum temperature of the hottest portion of the flame, as measured with a calibrated thermocouple pyrometer, may not be less than 1750° F. The burner must be positioned so that the hottest portion of the flame is applied to the test mark on the wire. Flame time, burn length, and flaming time of drippings, if any, must be recorded. The burn length determined in accordance with

paragraph (8) of this paragraph must be measured to the nearest 1/10-inch. Breaking of the wire specimens is not considered a failure.

(8) *Burn length.* Burn length is the distance from the original edge to the farthest evidence of damage to the test specimen due to flame impingement, including areas of partial or complete consumption, charring, or embrittlement, but not including areas sooted, stained, warped, or discoloured, nor areas where material has shrunk or melted away from the heat source.

(Change 525-3 (91-11-01))

(Change 525-6 (93-12-30))

Part II Flammability of Seat Cushions

(a) Criteria for Acceptance. Each seat cushion must meet the following criteria:

(1) At least three sets of seat bottom and seat back cushion specimens must be tested.

(2) If the cushion is constructed with a fire blocking material, the fire blocking material must completely enclose the cushion foam core material.

(3) Each specimen tested must be fabricated using the principal components (i.e. foam core, flotation material, fire blocking material, if used, and dress covering) and assembly processes (representative seams and closures) intended for use in the production articles. If a different material combination is used for the back cushion than for the bottom cushion, both material combinations must be tested as complete specimen sets, each set consisting of a back cushion specimen and a bottom cushion specimen. If a cushion, including outer dress covering, is demonstrated to meet the requirements of this appendix using the oil burner test, the dress covering of that cushion may be replaced with a similar dress covering provided the burn length of the replacement covering, as determined by the test specified in 525.853(c), does not exceed the corresponding burn length of the dress covering used on the cushion subjected to the oil burner test.

(4) For at least two-thirds of the total number of specimen sets tested, the burn length from the burner must not reach the side of the cushion opposite the burner. The burn length must not exceed 17 inches. Burn length is the perpendicular distance from the inside edge of the seat frame closest to the burner to the farthest evidence of damage to the test specimen due to flame impingement, including areas of partial or complete consumption, charring, or embrittlement, but not including areas soothed, stained, warped, or discoloured, or areas where material has shrunk or melted away from the heat source.

(5) The average percentage weight loss must not exceed 10 percent. Also, at least two-thirds of the total number of specimen sets tested must not exceed 10 percent weight loss. All droppings falling from the cushions and mounting stand are to be discarded before the after test weight is determined. The percentage weight loss for a specimen set is the weight of the specimen set before testing less the weight of the specimen set after testing expressed as the percentage of the weight before testing.

(b) Test Conditions. Vertical air velocity should average 25fpm$\pm$10fpm at the top of the back seat cushion. Horizontal air velocity should be below 10 fpm just above the bottom seat

cushion. Air velocities should be measured with the ventilation hood operating and the burner motor off.

(c) Test Specimens.

(1) For each test, one set of cushion specimens representing a seat bottom and seat back cushion must be used.

(2) The seat bottom cushion specimen must be 18±1/8 inches (457±3mm) wide by 20±1/8 inches (508±3mm) deep by 4±1/8 inches (102±3mm) thick, exclusive of fabric closures and seam overlap.

(3) The seat back cushion specimen must be 18±1/8 inches (457±3mm) wide by 25±1/8 inches (635±3mm) high by 2±1/8 inches (51±3mm) thick, exclusive of fabric closures and seam overlap.

(4) The specimens must be conditioned at 70±5°F (21±2°C) 55%±10% relative humidity for at least 24 hours before testing.

(d) Test Apparatus. The arrangement of the test apparatus is shown in Figures 1 through 5 and must include the components described in this section. Minor details of the apparatus may vary, depending on the model burner used.

(1) *Specimen Mounting Stand.* The mounting stand for the test specimens consists of steel angles, as shown in Figure 1. The length of the mounting stand legs is 12±1/8 inches (305±3mm). The mounting stand must be used for mounting the test specimen seat bottom and seat back, as shown in Figure 2. The mounting stand should also include a suitable drip pan lined with aluminum foil, dull side up.

(2) *Test Burner.* The burner to be used in testing must :

(i) Be a modified gun type

(ii) Have an 80-degree spray angle nozzle nominally rated for 2.25 gallons/hour at 100psi;

(iii) Have a 12-inch (305mm) burner cone installed at the end of the draft tube, with an opening 6 inches (152mm) high and 11 inches (280mm) wide, as shown in Figure 3; and

(iv) Have a burner fuel pressure regulator that is adjusted to deliver a nominal 2.0 gallon/hour of #2 Grade kerosene or equivalent required for the test.

Burner models which have been used successfully in testing are the Lennox Model 0B-32, Carlin Model 200 CRD, and Park Model DPL 3400. The Federal Aviation Administration (U.S.) published reports pertinent to this type of burner are: (1) Powerplant Engineering Report No. 3A, Standard Fire Test Apparatus and Procedure for Flexible Hose Assemblies, dated March 1978; and (2) Report No. DOT/FAA/RD/76/213, Re-evaluation of Burner Characteristics for Fire Resistance Tests, dated January 1977.

(3) *Calorimeter.*

(i) The calorimeter to be used in testing must be a (0-15.0 BTU/ft^2-sec. 0-17.0 w/cm^2) calorimeter, accurate $\pm$3%, mounted in a 6-inch by 12-inch (152 by 305mm) by 3/4-inch (19mm) thick calcium silicate insulating board which is attached to a steel angle bracket for placement in the test stand during burner calibration, as shown in Figure 4.

(ii) Because crumbling of the insulating board with service can result in misalignment of the calorimeter, the calorimeter must be monitored and the mounting shimmed, as necessary, to ensure that the calorimeter face is flush with the exposed plane of the insulating board in a plane parallel to the exit of the test burner cone.

(4) *Thermocouples.* The seven thermocouples to be used for testing must be 1/16 to 1/8-inch metal sheathed, ceramic packed, type K, grounded thermocouples with a nominal 22 to 30 American wire gauge (AWG)-size conductor. The seven thermocouples must be attached to a steel angle bracket to form a thermocouple rake for placement in the test stand during burner calibration, as shown in Figure 5.

(5) *Apparatus Arrangement.* The test burner must be mounted on a suitable stand to position the exit of the burner cone a distance of 4$\pm$1/8 inches (102$\pm$3mm) from one side of the specimen mounting stand. The burner stand should have the capability of allowing the burner to be swung away from the specimen mounting stand during warm-up periods.

(6) *Data Recording.* A recording potentiometer or other suitable calibrated instrument with an appropriate range must be used to measure and record the outputs of the calorimeter and the thermocouples.

(7) *Weight Scale.* Weighing Device A device must be used that with proper procedures may determine the before and after test weights of each set of seat cushion specimens within 0.02 pounds (9 grams). A continuous weighing system is preferred.

(8) *Timing Device.* A stopwatch or other device (calibrated to $\pm$1 second) must be used to measure the time of application of the burner flame and self-extinguishing time or test duration.

(e) Preparation of Apparatus. Before calibration, all equipment must be turned on and the burner fuel must be adjusted as specified in paragraph *(d)*(2).

(f) Calibration. To ensure the proper thermal output of the burner, the following test must be made:

(1) Place the calorimeter on the test stand as shown in Figure 4 at a distance of 4$\pm$1/8 inches (102$\pm$3mm) from the exit of the burner cone.

(2) Turn on the burner, allow it to run for 2 minutes for warm-up, and adjust the burner air intake damper to produce a reading of 10.5$\pm$0.5 BTU/ft^2 sec. (11.9$\pm$0.6 w/cm^2) on the calorimeter to ensure steady state conditions have been achieved. Turn off the burner.

(3) Replace the calorimeter with the thermocouple rake (Figure 5).

(4) Turn on the burner and ensure that the thermocouples are reading 1900±100°F (1038±38°C) to ensure steady state conditions have been achieved.

(5) If the calorimeter and thermocouples do not read within range, repeat steps in paragraphs 1 through 4 and adjust the burner air intake damper until the proper readings are obtained. The thermocouple rake and the calorimeter should be used frequently to maintain and record calibrated test parameters. Until the specific apparatus has demonstrated consistency, each test should be calibrated. After consistency has been confirmed, several tests may be conducted with the pre-test calibration before and a calibration check after the series.

(g) Test Procedure. The flammability of each set of specimens must be tested as follows:

(1) Record the weight of each set of seat bottom and seat back cushion specimens to be tested to the nearest 0.02 pounds (9 grams).

(2) Mount the seat bottom and seat back cushion test specimens on the test stand as shown in Figure 2, securing the seat back cushion specimen to the test stand at the top.

(3) Swing the burner into position and ensure that the distance from the exit of the burner cone to the side of the seat bottom cushion specimen is 4±1/8 inches (102±3mm).

(4) Swing the burner away from the test position. Turn on the burner and allow it to run for 2 minutes to provide adequate warm-up of the burner cone and flame stabilisation.

(5) To begin the test, swing the burner into the test position and simultaneously start the timing device.

(6) Expose the seat bottom cushion specimen to the burner flame for 2 minutes and them turn off the burner. Immediately swing the burner away from the test position. Terminate test 7 minutes after initiating cushion exposure to the flame by use of a gaseous extinguishing agent (i.e. Halon or CO_2).

(7) Determine the weight of the remains of the seat cushion specimen set left on the mounting stand to the nearest 0.02 pounds (9 grams) excluding all droppings.

(h) Test Report. With respect to all specimen sets tested for a particular seat cushion for which testing of compliance is performed, the following information must be recorded:

(1) An identification and description of the specimens being tested.

(2) The number of specimen sets tested.

(3) The initial weight and residual weight of each set, the calculated percentage weight loss of each set, and the calculated average percentage weight loss for the total number of sets tested.

(4) The burn length for each set tested.

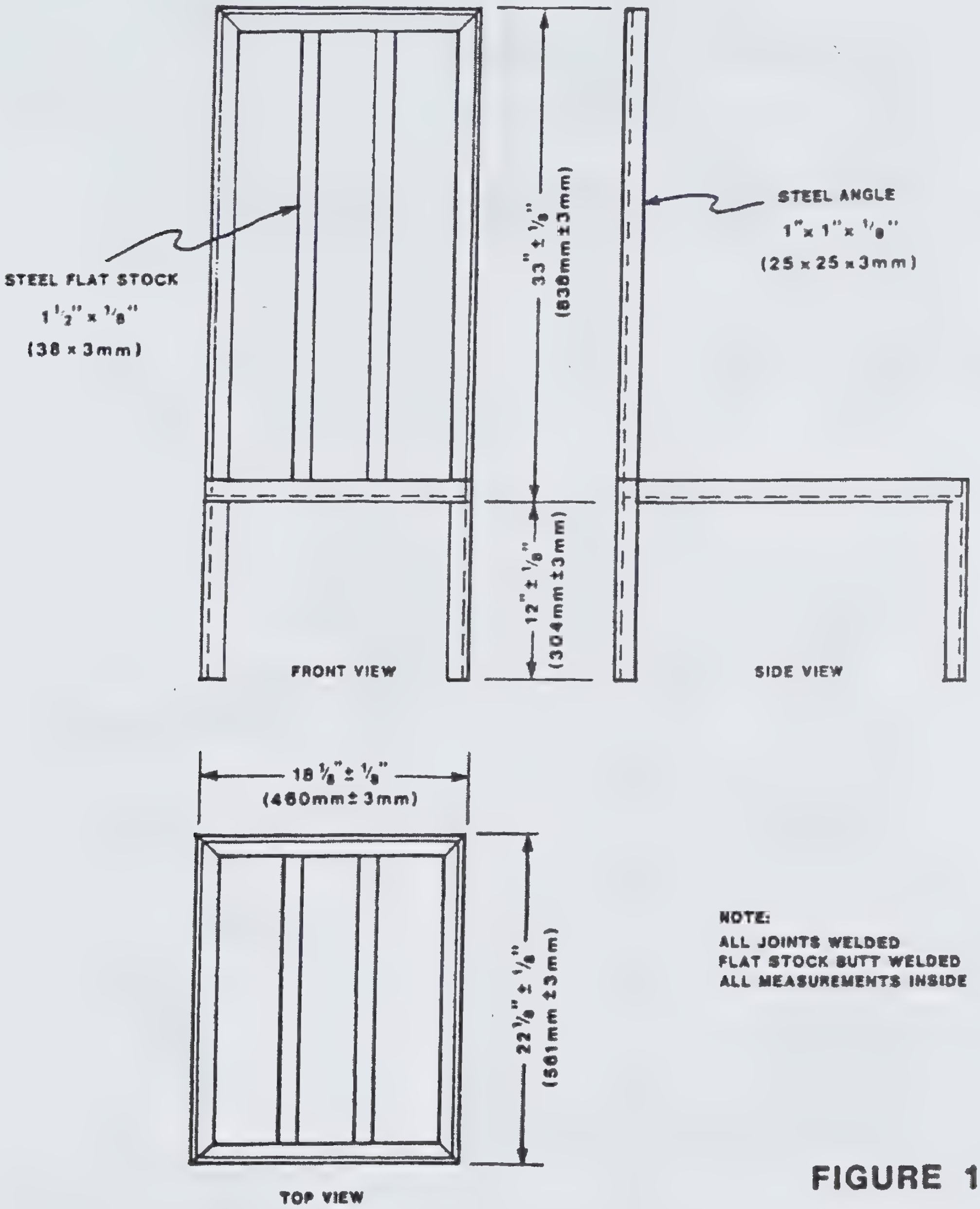

STEEL FLAT STOCK
1 1/2" x 1/8"
(38 x 3mm)
STEEL ANGLE
1" x 1" x 1/8"
(25 x 25 x 3mm)
33" ± 1/8"
(838mm ±3mm)
12" ± 1/8"
(304mm ±3mm)
FRONT VIEW
SIDE VIEW
18 1/8" ± 1/8"
(460mm ± 3mm)
22 1/8" ± 1/8"
(561mm ±3mm)
TOP VIEW
NOTE:
ALL JOINTS WELDED
FLAT STOCK BUTT WELDED
ALL MEASUREMENTS INSIDE

FIGURE 1

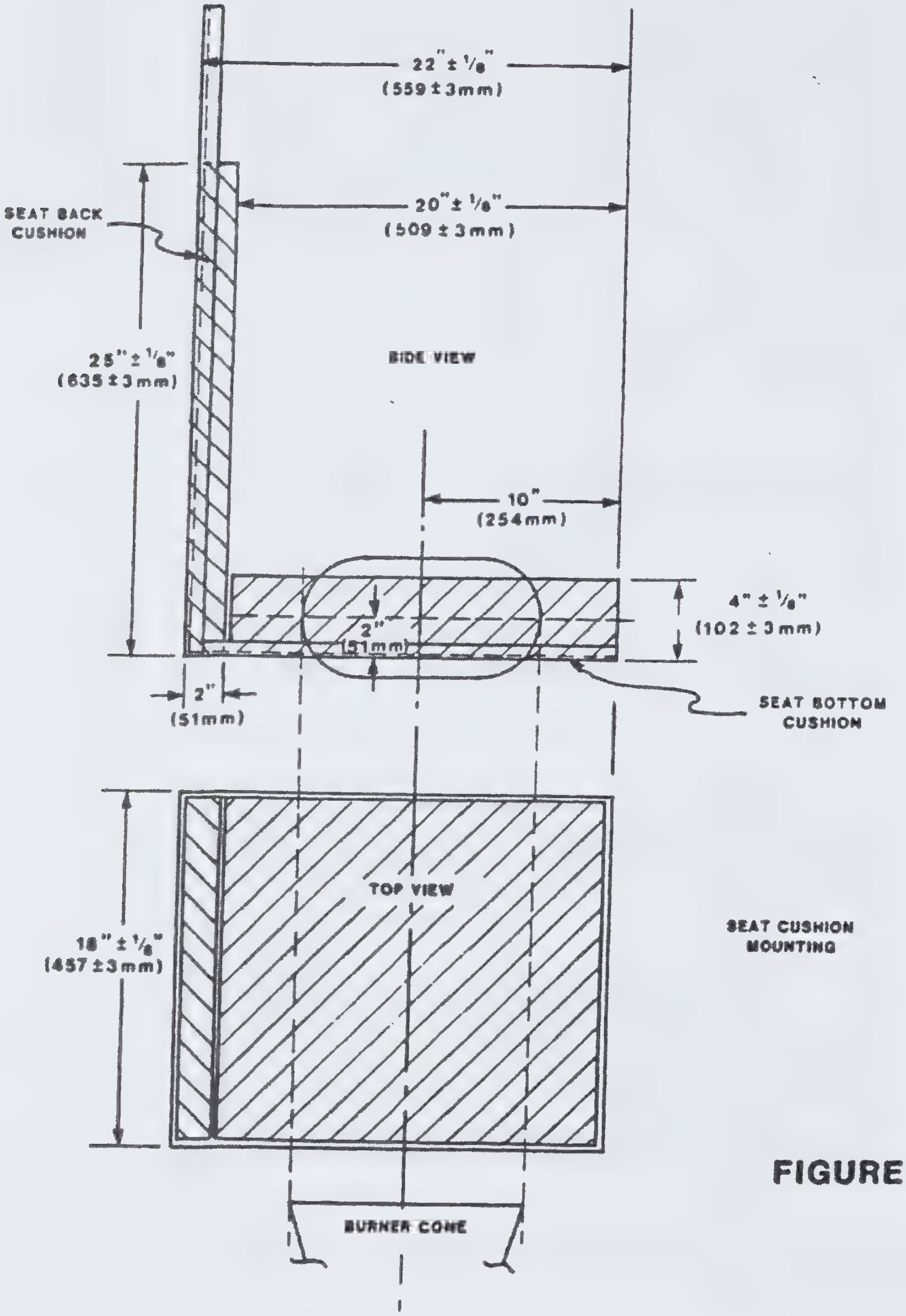

22" ± 1/8"
(559 ± 3mm)
20" ± 1/8"
(509 ± 3mm)
SEAT BACK
CUSHION
25" ± 1/8"
(635 ± 3mm)
SIDE VIEW
10"
(254mm)
4" ± 1/8"
(102 ± 3mm)
2"
(51mm)
2"
(51mm)
SEAT BOTTOM
CUSHION
TOP VIEW
18" ± 1/8"
(457 ± 3mm)
SEAT CUSHION
MOUNTING
BURNER CONE

FIGURE 2

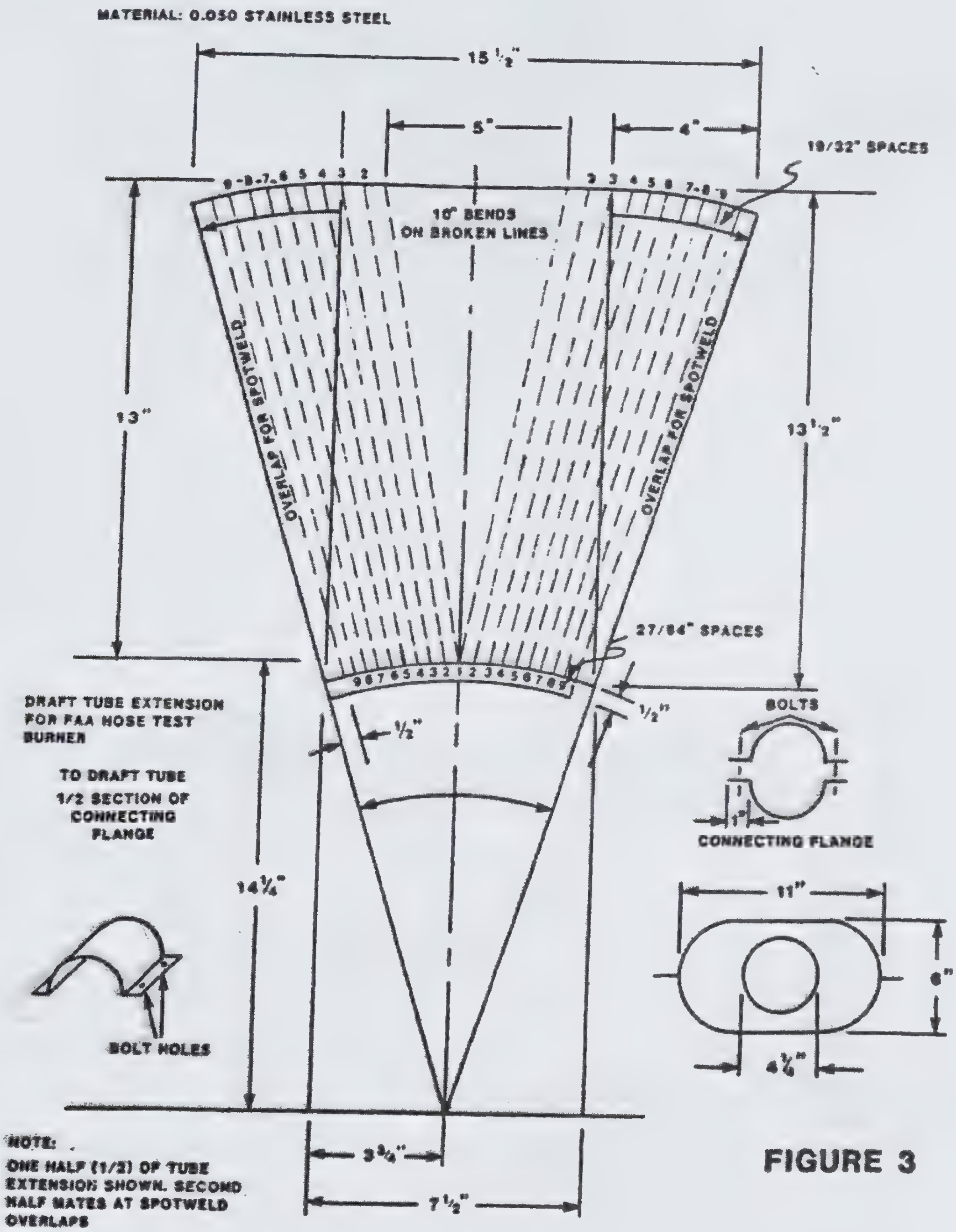

MATERIAL: 0.050 STAINLESS STEEL
15 1/2"
5"
4"
19/32" SPACES
10° BENDS
ON BROKEN LINES
OVERLAP FOR SPOTWELD
OVERLAP FOR SPOTWELD
13"
13 1/2"
27/64" SPACES
1/2"
1/2"
DRAFT TUBE EXTENSION
FOR FAA HOSE TEST
BURNER
TO DRAFT TUBE
1/2 SECTION OF
CONNECTING
FLANGE
BOLTS
1"
CONNECTING FLANGE
14 1/4"
11"
6"
4 3/4"
BOLT HOLES
3 3/4"
7 1/2"
NOTE:
ONE HALF (1/2) OF TUBE
EXTENSION SHOWN. SECOND
HALF MATES AT SPOTWELD
OVERLAPS

FIGURE 3

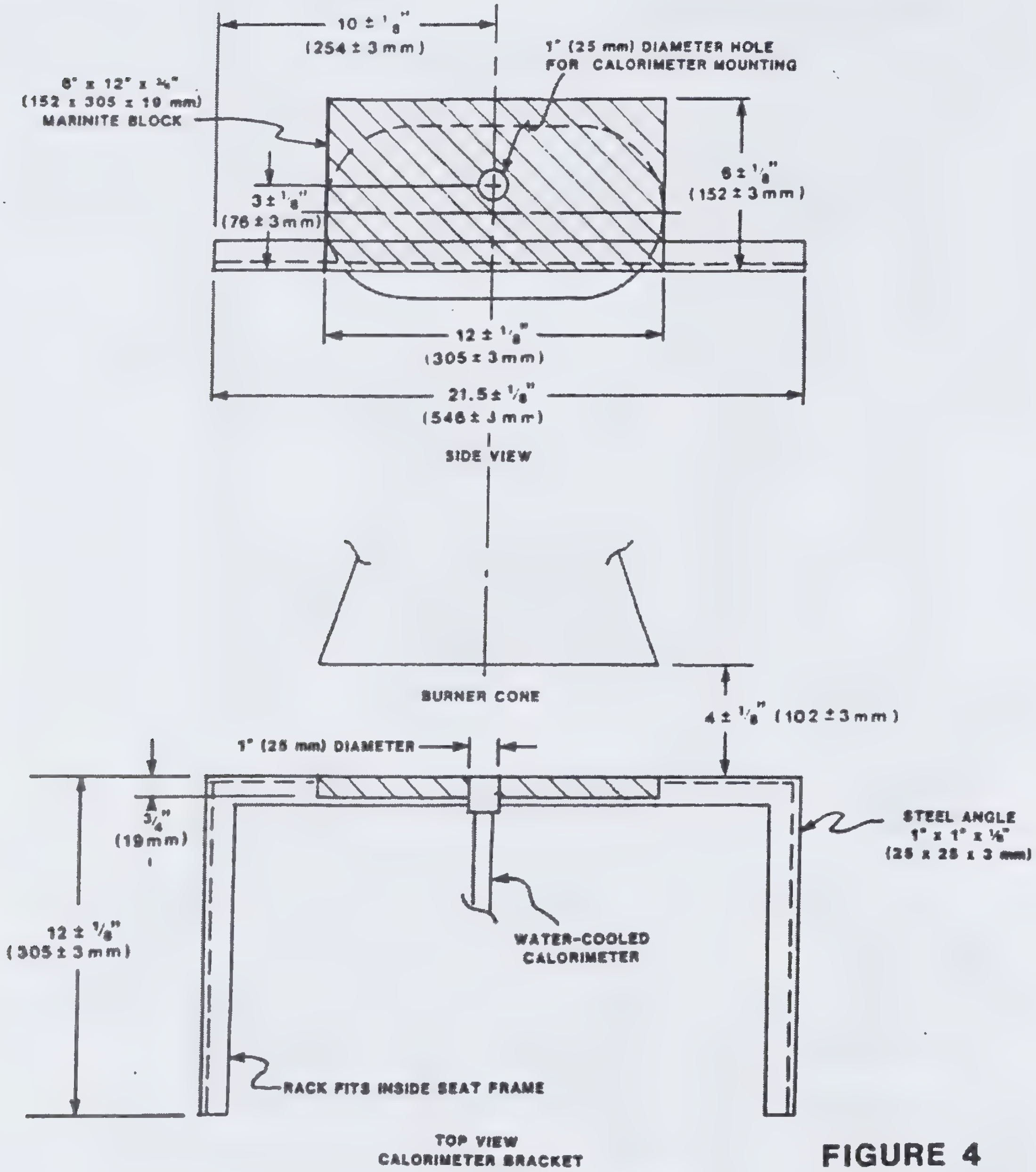

10 ± 1/8"
(254 ± 3 mm)
1" (25 mm) DIAMETER HOLE
FOR CALORIMETER MOUNTING
6" x 12" x 3/4"
(152 x 305 x 19 mm)
MARINITE BLOCK
3 ± 1/8"
(76 ± 3 mm)
6 ± 1/8"
(152 ± 3 mm)
12 ± 1/8"
(305 ± 3 mm)
21.5 ± 1/8"
(546 ± 3 mm)
SIDE VIEW
BURNER CONE
4 ± 1/8" (102 ± 3 mm)
1" (25 mm) DIAMETER
3/4"
(19 mm)
STEEL ANGLE
1" x 1" x 1/8"
(25 x 25 x 3 mm)
12 ± 1/8"
(305 ± 3 mm)
WATER-COOLED
CALORIMETER
RACK FITS INSIDE SEAT FRAME
TOP VIEW
CALORIMETER BRACKET

FIGURE 4

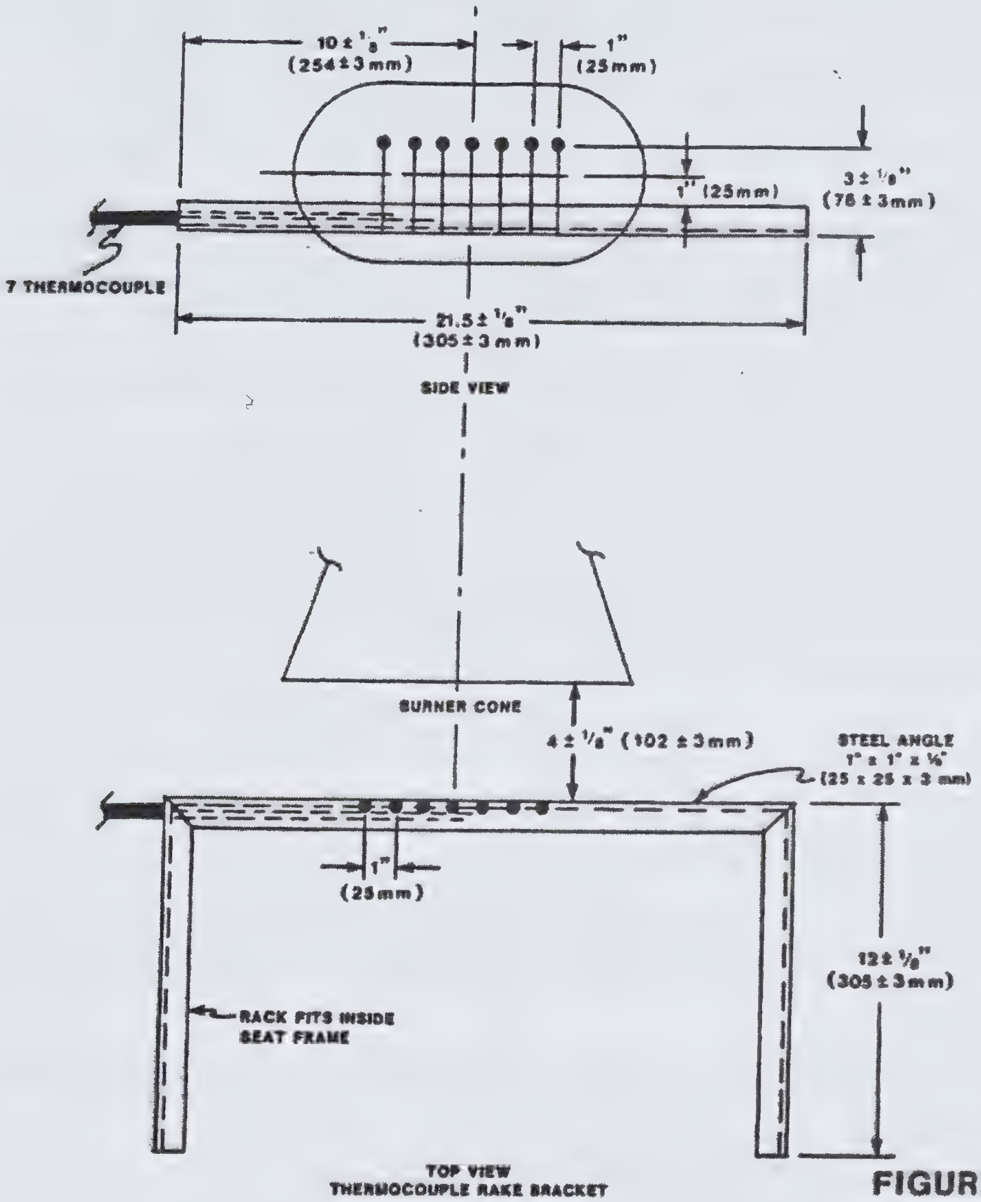

10 ± 1/8"
(254 ± 3 mm)
1"
(25 mm)
1" (25 mm)
3 ± 1/8"
(76 ± 3 mm)
7 THERMOCOUPLE
21.5 ± 1/8"
(305 ± 3 mm)
SIDE VIEW
BURNER CONE
4 ± 1/8" (102 ± 3 mm)
STEEL ANGLE
1" x 1" x 1/8"
(25 x 25 x 3 mm)
1"
(25 mm)
12 ± 1/8"
(305 ± 3 mm)
RACK FITS INSIDE
SEAT FRAME
TOP VIEW
THERMOCOUPLE RAKE BRACKET

FIGURE 5

Part III Test Method to Determine Flame Penetration Resistance of Cargo Compartment Liners

(a) Criteria for Acceptance.

(1) At least three specimens of cargo compartment sidewall or ceiling liner panels must be tested.

(2) Each specimen tested must simulate the cargo compartment sidewall or ceiling liner panel, including any design features, such as joints, lamp assemblies, etc., the failure of which would affect the capability of the liner to safety contain a fire.

(3) There must be no flame penetration of any specimen within 5 minutes after application of the flame source, and the peak temperature measured at 4 inches above the upper surface of the horizontal test sample must not exceed 400°F.

(b) Summary of Method. This method provides a laboratory test procedure for measuring the capability of cargo compartment lining materials to resist flame penetration with a 2 gallon per hour (GPH) #2 Grade kerosene or equivalent burner fire source. Ceiling and sidewall liner panels may be tested individually provided a baffle is used to simulate the missing panel. Any specimen that passes the test as a ceiling liner panel may be used as a sidewall liner panel.

(c) Test Specimens.

(1) The specimen to be tested must measure 16 ± 1/8 inches (406 ± 3 mm) by 24 ± 1/8 inches (610 ± 3mm).

(2) The specimens must be conditioned at 70°F ±5°F (21°C ± 2°C) and 55% ± 5% humidity for at least 24 hours before testing.

(d) Test Apparatus. The arrangement of the test apparatus, which is shown in Figure 3 of Part II and Figures 1 through 3 of this Part of Appendix F, must include the components described in this section. Minor details of the apparatus may vary, depending on the model of the burner used.

(1) *Specimen Mounting Stand.* The mounting stand for the test specimens consists of steel angles as shown in Figure 1.

(2) *Test Burner.* The burner to be used in testing must:

(i) Be a modified gun type.

(ii) Use a suitable nozzle and maintain fuel pressure to yield a 2 GPH fuel flow. For example: an 80 degree nozzle nominally rated at 2.25 GPH and operated at 85 pounds per square inch (PSI) gauge to deliver 2.03 GPH.

(iii) Have a 12 inch (305 mm) burner extension installed at the end of the draft tube with an opening 6 inches (152 mm) high and 11 inches (280 mm) wide as shown in Figure 3 of Part II of this Appendix.

(iv) Have a burner fuel pressure regulator that is adjusted to deliver a nominal 2.0 GPH of #2 Grade kerosene or equivalent. Burner models which have been used successfully in testing are the Lenox Model OB-32, Carlin Model 200 CRD and

Park Model DPL. The basic burner is described in FAA Powerplant Engineering Report No. 3A, Standard Fire Test Apparatus and Procedures for Flexible Hose Assemblies, dated March 1978; however, the test settings specified in this Appendix differ in some instances from those specified in the report.

(3) *Calorimeter.*

(i) The calorimeter to be used in testing must be a total heat flux Foil Type Gardon Gauge of an appropriate range (approximately 0 to 15.0 British thermal unit (BTU) per ft.^{2} sec., 0-17.0 watts/cm^2). The calorimeter must be mounted in a 6 inch by 12 inch (152 by 305 mm) by 3/4 inch (19 mm) thick insulating block which is attached to a steel angle bracket for placement in the test stand during burner calibration as shown in Figure 2 of this Part of this Appendix.

(ii) The insulating block must be monitored for deterioration and the mounting shimmed as necessary to ensure that the calorimeter face is parallel to the exit plane of the test burner cone.

(4) *Thermocouples.* The seven thermocouples to be used for testing must be 1/16 inch ceramic sheathed, type K, grounded thermocouples with a nominal 30 American wire gauge (AWG) size conductor. The seven thermocouples must be attached to a steel angle bracket to form a thermocouple rake for placement in the stand during burner calibration as shown in Figure 3 of this Part of this Appendix.

(5) *Apparatus Arrangement.* The test burner must be mounted on a suitable stand to position the exit of the burner cone a distance of 8 inches from the ceiling liner panel and 2 inches from the sidewall liner panel. The burner stand should have the capability of allowing the burner to be swung away from the test specimen during warm-up periods.

(6) *Instrumentation.* A recording potentiometer or other suitable instrument with an appropriate range must be used to measure and record the outputs of the calorimeter and the thermocouples.

(7) *Timing Device.* A stopwatch or other device must be used to measure the time of flame application and the time of flame penetration, if it occurs.

(e) Preparation of Apparatus. Before calibration, all equipment must be turned on and allowed to stabilise, and the burner fuel flow must be adjusted as specified in paragraph *(d)*(2).

(f) Calibration. To ensure the proper thermal output of the burner the following test must be made:

(1) Remove the burner extension from the end of the draft tube. Turn on the blower portion of the burner without turning the fuel or igniters on. Measure the air velocity using a hot wire anemometer in the centre of the draft tube across the face of the opening. Adjust the damper such that the air velocity is in the range of 1550 to 1800 ft./min. If tabs are being used at the exit of the draft tube, they must be removed prior to this measurement. Reinstall the draft tube extension cone.

(2) Place the calorimeter on the test stand as shown in Figure 2 at a distance of 8 inches (203 mm) from the exit of the burner cone to simulate the position of the horizontal test specimen.

(3) Turn on the burner, allow it to run for 2 minutes for warm-up, and adjust the damper to produce a calorimeter reading of 8.0 $\pm$ 0.5 BTU per ft.^{2} sec. (9.1 $\pm$ 0.6 Watts/cm^2).

(4) Replace the calorimeter with the thermocouples rake (see Figure 3).

(5) Turn on the burner and ensure that each of the seven thermocouples reads 1700°F $\pm$ 100°F (927°C $\pm$ 38°C) to ensure steady state conditions have been achieved. If the temperature is out of this range, repeat steps 2 through 5 until proper readings are obtained.

(6) Turn off the burner and remove the thermocouple rake.

(7) Repeat (1) to ensure that the burner is in the correct range.

(g) Test Procedure.

(1) Mount a thermocouple of the same type as that used for calibration at a distance of 4 inches (101 mm) above the horizontal (ceiling) test specimen. The thermocouple should be centred over the burner cone.

(2) Mount the test specimen on the test stand shown in Figure 1 in either the horizontal or vertical position. Mount the insulating material in the other position.

(3) Position the burner so that flames will not impinge on the specimen, turn the burner on, and allow it to run for 2 minutes. Rotate the burner to apply the flame to the specimen and simultaneously start the timing device.

(4) Expose the test specimen to the flame for 5 minutes and then turn off the burner.

The test flame may be terminated earlier if flame penetration is observed.

(5) When testing ceiling liner panels, record the peak temperature measured 4 inches above the sample.

(6) Record the time at which flame penetration occurs if applicable.

(h) Test Report. The test report must include the following:

(1) A complete description of the materials tested including type, manufacturer, thickness, and other appropriate data.

(2) Observations of the behaviour of the test specimens during flame exposure such as delamination, resin ignition, smoke, etc., including the time of such occurrence.

(3) The time at which flame penetration occurs, if applicable, for each of the three specimens tested.

(4) Panel orientation (ceiling or sidewall).

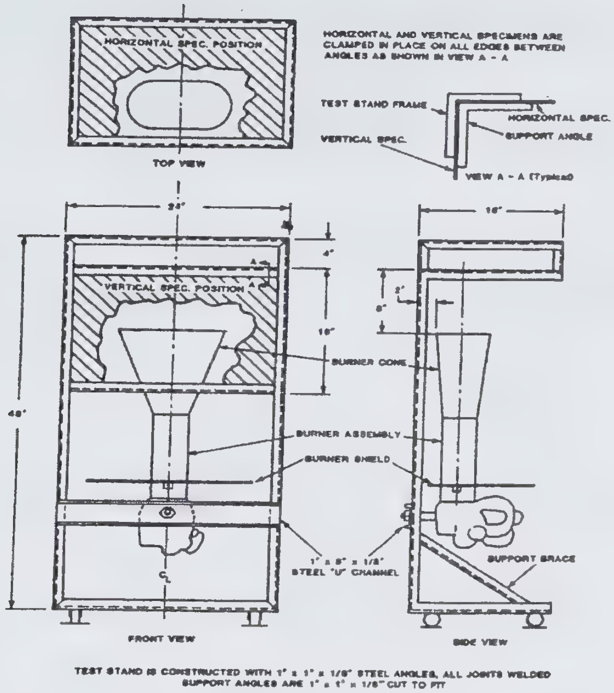


FIGURE 1 - Test Apparatus for Horizontal and Vertical Mounting

Figure 1 - Test Apparatus for Horizontal and Vertical Mounting

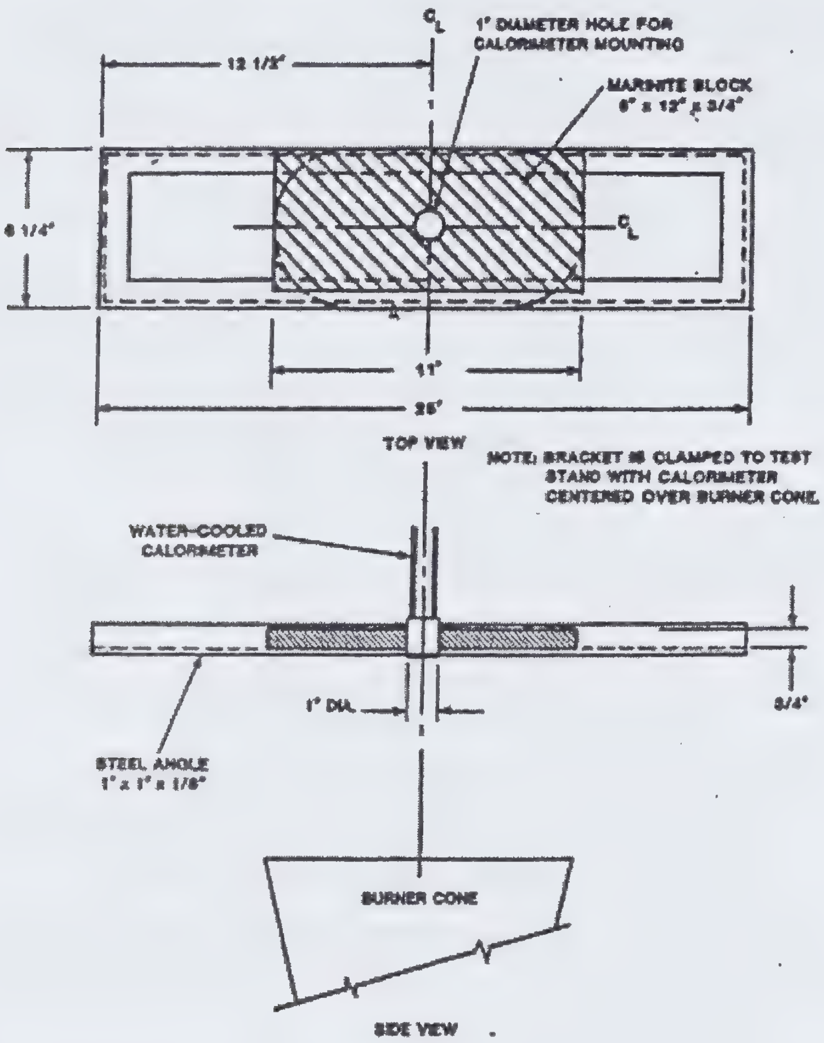


Figure 2 - Calorimeter Bracket

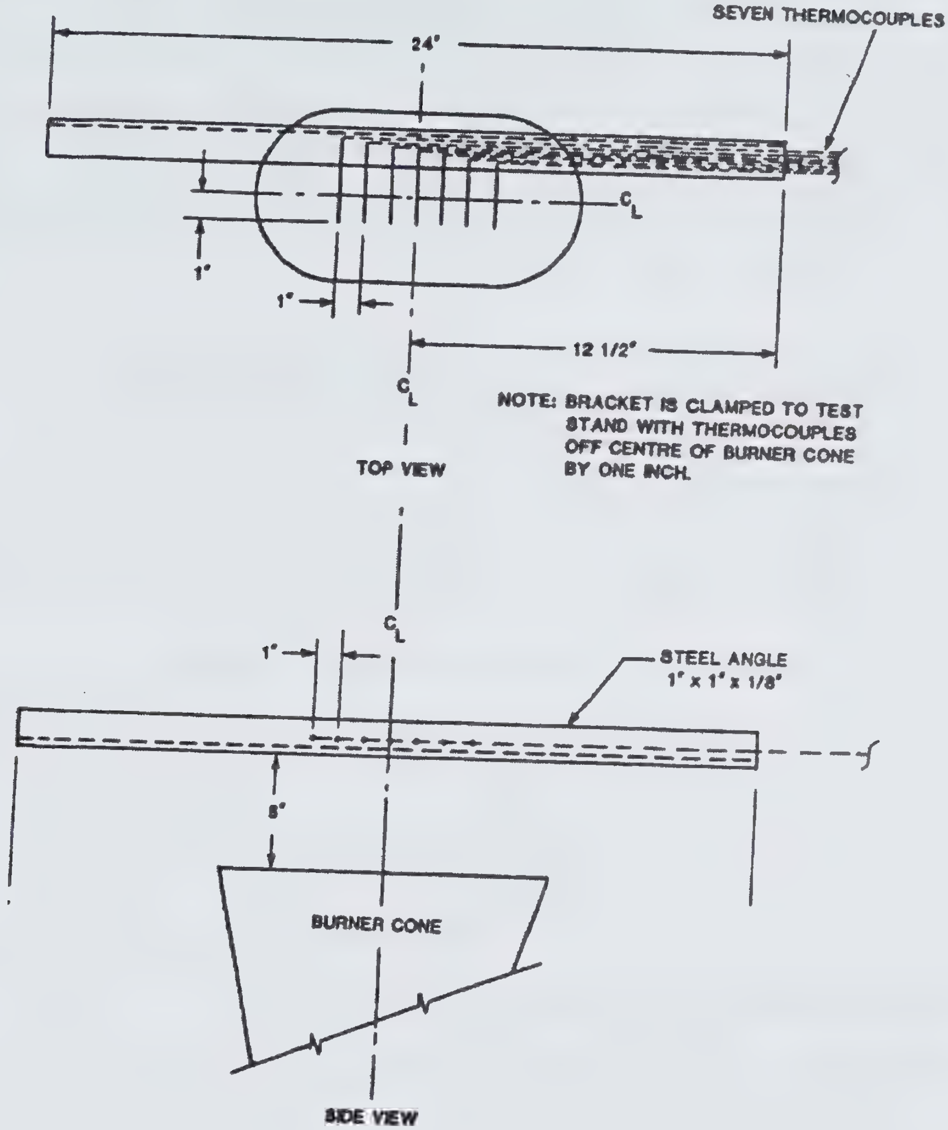


Figure 3 - Thermocouple Rake Bracket

Part IV Test Method to Determine the Heat Release Rate From Cabin Materials Exposed to Radiant Heat

(a) Summary of Method. Three or more specimens representing the completed aircraft component are tested. Each test specimen is injected into an environmental chamber through which a constant flow of air passes. The specimen's exposure is determined by a radiant heat source adjusted to produce, on the specimen, the desired total heat flux of 3.5 W/cm^2. The specimen is tested with the exposed surface vertical. Combustion is initiated by piloted ignition. The combustion products leaving the chamber are monitored in order to calculate the release rate of heat.

(b) Apparatus. The Ohio State University (OSU) rate of heat release apparatus, as described below, is used. This is a modified version of the rate of heat release apparatus standardised by the American Society of Testing and Materials (ASTM), ASTM E-906.

(1) This apparatus is shown in Figures F-1Aand F-1B of this Part IV. All exterior surfaces of the apparatus, except the holding chamber, must be insulated with 1 inch (25 mm) thick, low density, high temperature, fibreglass board insulation. A gasketed door, through which the sample injection rod slides, must be used to form an airtight closure on the specimen hold chamber.

(2) *Thermopile.* The temperature difference between the air entering the environmental chamber and that leaving must be monitored by a thermopile having five hot, and five cold, 24-gauge Chromel-Alumel junctions. The hot junctions must be spaced across the top of the exhaust stack, .38 inches (10 mm) below the top of the chimney. The thermocouples must have a .050 $\pm$ .010 inch (1.3 $\pm$ 3 mm) diameter, ball-type, welded tip. One thermocouple must be located in the geometric center, with the other four located 1.18 inch (30 mm) from the center along the diagonal toward each of the corners (Figure 5 of this Part IV). The cold junctions must be located in the pan below the lower air distribution plate (see paragraph (b)(4) of this Part IV). Thermopile hot junctions must be cleared of soot deposits as needed to maintain the calibrated sensitivity.

(3) *Radiation Source.* A radiant heat source incorporating four Type LL silicon carbide elements, 20 inches (508 mm) long by .63 inch (16 mm) O.D., must be used, as shown in Figures F-2A and F-2B of this Part IV. The heat source must have a nominal resistance of 1.4 ohms and be capable of generating a flux up to 100 kW/m2. The silicone carbide elements must be mounted in the stainless steel panel box by inserting them through .63 inch (16 mm) holes in .03 inch (1 mm) thick ceramic fibre or calcium-silicate millboard. Locations of the holes in the pads and stainless steel cover plates are shown in Figure F-2B of this Part IV. The truncated diamond-shaped mask of 042 + .002 inch (1.07 + 0.5 mm) stainless steel must be added to provide uniform heat flux density over the area occupied by the vertical sample.

(4) *Air Distribution System.* The air entering the environmental chamber is distributed by a .25 inch (6.3 mm) thick aluminum plate having eight No. 4 drill-holes, located 2 inches (51 mm) from sides on 4 inch (102 mm) centres, mounted at the base of the environmental chamber. A second plate of 18-gauge steel having 120, evenly-spaced, No.28 drill holes must be mounted 6 inches (152 mm) above the aluminum plate. A well-regulated air supply

is required. The air supply manifold at the base of the pyramidal section must have 48, evenly-spaced, No.26 drill holes located .38 inch (10 mm) from the inner edge of the manifold, resulting in an airflow split of approximately three to one within the apparatus.

(5) *Exhaust Stack.* An exhaust stack, 5.25 x 2.75 (133 mm by 70 mm) in cross-section and 10 inches (254 mm) long, fabricated from 28-gauge stainless steel, must be mounted on the outlet of the pyramidal section. A 1.0 x 3.0 inch (25 by 76 mm) baffle plate of .018 ± .002 inch (.50 ± .05 mm) stainless steel must be centred inside the stack, perpendicular to the air flow, 3 inches (76 mm) above the base of the stack.

(6) *Specimen Holders*

(i) The specimen must be tested in a vertical orientation. The specimen holder (Figure 3 of this Part IV) must incorporate a frame that touches the specimen (which is wrapped with aluminum foil as required by paragraph (d)(3) of this Part) along only the 25 inch (6 mm) perimeter. A "V" shaped spring is used to hold the assembly together. A detachable 50 x .5 x 5.91 inch (12 x 12 x 150 mm) drip pan and two .020 inch (.5 mm) stainless steel wires (as shown in Figure 3 of this Part IV) must be used for testing materials prone to melting and dripping. The positioning of the spring and frame may be changed to accommodate different specimen thickness by inserting the retaining rod in different holes on the specimen holder.

(ii) Since the radiation shield described in ASTM E-906 is not used, a guide pin is added to the injection mechanism. This fits into a slotted metal plate on the injection mechanism outside of the holding chamber. It can be used to provide accurate positioning of the specimen face after injection. The front surface of the specimen must be 3.9 inches (100 mm) from the closed radiation doors after injection.

(iii) The specimen holder clips onto the mounted bracket (Figure 3 of this Part IV). The mounting bracket must be attached to the injection rod by three screws that pass through a wide-area washer welded onto a 1/2-inch (13 mm) nut. The end of the injection rod must be threaded to screw into the nut and a .020-inch (5.1 mm) thick wide area washer must be held between two ½-inch (13 mm) nuts that are adjusted to tightly cover the hole in the radiation doors through which the injection rod or calibration calorimeter pass.

(7) *Calorimeter* A total-flux type calorimeter must be mounted in the centre of a ½-inch Kaowool "M" board inserted in the sample holder to measure the total heat flux. The calorimeter must have a view angle of 180 degrees and be calibrated for incident flux. The calorimeter calibration must be acceptable to the Minister.

(8) *Pilot-Flame Positions.* Pilot ignition of the specimen must be accomplished by simultaneously exposing the specimen to a lower pilot burner and an upper pilot burner, as described in paragraph (b)(8)(i) and (b)(8)(ii) or (b)(8)(iii) of this Part IV, respectively. Since intermittent pilot flame extinguishment for more than 3 seconds would invalidate the test results, a spark ignitor may be installed to ensure that the lower pilot burner remains lighted.

(i) *Lower Pilot Burner.* The pilot-flame tubing must be .25 inch (6.3 mm) O.D., .03 inch (0.8 mm) wall, stainless steel tubing. A mixture of 120 cm+^{3}/min. of methane and 850 cm^3/min. of air must be fed to the lower pilot flame burner. The normal position of the end of the pilot burner tubing is .40 inch (10 mm) from and perpendicular to the exposed vertical surface of the specimen. The centreline at the outlet of the burner tubing must intersect the vertical centreline of the sample at a point .20 inch (5 mm) above the lower exposed edge of the specimen.

(ii) *Standard Three-Hole Upper Pilot Burner.* The pilot burner must be a straight length of .25 inch (6.3 mm) O.D., .03 inch (0.8 mm) wall, stainless steel tubing that is 14 inches (360 mm) long. One end of the tubing must be closed, and three No. 40 drill holes shall be drilled into the tubing, 2.38 inch (60 mm) apart, for gas ports, all radiating in the same direction. The first hole must be .19 inch (5 mm) from the closed end of the tubing. The tube must be positioned 75 (19 mm) above and .75 inch (19 mm) behind the exposed upper edge of the specimen. The middle hole must be in the vertical plane perpendicular to the exposed surface of the specimen which passes through its vertical centreline and must be pointed toward the radiation source. The gas supplied to the burner must be methane and must be adjusted to produce flame lengths of 1 inch (25 mm).

(iii) *Optional Fourteen-Hole Upper Pilot Burner.* This burner may be used in lieu of the standard three-hole burner described in paragraph (b)(8)(ii) of this Part IV. The pilot burner must be a straight length of .25 inch (6.3 mm) O.D., .03 inch (0.8 mm) wall, stainless steel tubing that is 15.75 inches (400 mm) long. On end of the tubing must be closed, and 14 No. 59 drill holes must be drilled into the tubing, .50 inch (13 mm) apart, for gas ports, all radiating in the same direction. The first hole must be .50 inch (13 mm) from the closed end of the tubing. The tube must be positioned above the specimen as shown in Figure F-1B of this Part IV. The fuel supplied to the burner must be methane mixed with air in a ratio of approximately 50/50 by volume. The total gas flow must be adjusted to produce flame lengths of 1 inch (25 mm). When the gas/air ratio and the flow rate are properly adjusted, approximately 25 inch (6 mm) of the flame length appears yellow in colour.

(c) Calibration of Equipment.

(1) *Heat Release Rate.* A calibration burner, as shown in Figure 4, must be placed over the end of the lower pilot flame tubing using a gas tight connection. The flow of gas to the pilot flame must be at least 99 percent methane and must be accurately metered. Prior to usage, the wet test meter must be properly levelled and filled with distilled water to the tip of the internal pointer while no gas is flowing. Ambient temperature and pressure of the water are based on the internal wet test meter temperature. A baseline flow rate of approximately 1 litre/min. is set and increased to higher pre-set flows of 4, 6, 8, 6 and 4 litres/min. Immediately prior to recording methane flow rates, a flow rate of 8 litres/min. must be used for 2 minutes to precondition the chamber. This is not recorded as part of calibration. The rate must be determined by using a stopwatch to time a complete revolution of the wet test meter for both the baseline and higher flow, with the flow returned to baseline before changing to the next higher flow. The thermopile baseline voltage must be measured. The

gas flow to the burner must be increased to the higher pre-set flow and allowed to burn for 2.0 minutes, and the thermopile voltage must be measured. The sequence must be repeated until all five values have been determined. The average of the five values must be used as the calibration factor. The procedure must be repeated if the percent relative standard deviation is greater than 5 percent. Calculations are shown in paragraph (f) of this Part IV.

(2) *Flux Uniformity.* Uniformity of flux over the specimen must be checked periodically and after each heating element change to determine if it is within acceptable limits of plus or minus 5 percent.

(3) As noted in paragraph (b)(2) of this Part IV, thermopile hot junctions must be cleared of soot deposits as needed to maintain the calibrated sensitivity.

(d) Preparation of Test Specimens.

(1) The test specimens must be representative of the aircraft component in regard to materials and construction methods. The standard size for the test specimens is 5.91 $\pm$ 1 x 149 $\pm$ 1 mm). The thickness of the specimen must be the same as that of the aircraft component it represents up to a maximum thickness of 1.75 inches (45 mm). Test specimens representing thicker components must be 1.75 inches (45 mm).

(2) *Conditioning.* Specimens must be conditioned as described in Part I of this Appendix.

(3) *Mounting.* Each test specimen must be wrapped tightly on all sides of the specimen, except for the one surface that is exposed with a single layer of .001 inch (.025 mm) aluminum foil.

(e) Procedure.

(1) The power supply to the radiant panel is set to produce a radiant flux of 3.5 $\pm$ .05 W/cm^2, as measured at the point the centre of the specimen surface will occupy when positioned for the test. The radiant flux must be measured after the air flow through the equipment is adjusted to the desired rate.

(2) After the pilot flames are lighted, their position must be checked as described in paragraph (b)(8) of this Part IV.

(3) Air flow through the apparatus must be controlled by a circular plate orifice located in a 1.5 inch (38.1 mm) I.D. pipe with two pressure measuring points, located 1.5 inches (38 mm) upstream and .75 inches (19 m) downstream of the orifice plate. The pipe must be connected to a manometer set at a pressure differential of 7.87 inches (200 mm) of Hg. (See Figure F-1B of this Part IV). The total air flow to the equipment is approximately .04 m$^{3/}$ seconds. The stop on the vertical specimen holder rod must be adjusted so that the exposed surface of the specimen is positioned 3.9 inches (100 mm) from the entrance when injected into the environmental chamber.

(4) The specimen must be placed in the hold chamber with the radiation doors closed. The airtight outer door must be secured, and the recording devices must be started. The specimen must be retained in the hold chamber for 60 seconds, plus or minus 10 seconds, before injection. The thermopile "zero" value must be determined during the last 20

seconds of the hold period. The sample must not be injected before completion of the "zero" value determination.

(5) When the specimen is to be injected, the radiation doors must be opened. After the specimen is injected into the environmental chamber, and the radiation doors must be closed behind the specimen.

(6) (Reserved)

(7) Injection of the specimen and closure of the inner door marks time zero. A continuous record of the thermopile output must be made during the time the specimen is in the environmental chamber.

(8) The test duration time is five minutes. The lower pilot burner and the upper pilot burner must remain lighted for the entire duration of the test, except that there may be intermittent flame extinguishment for periods that do not exceed 3 seconds. Furthermore, if the optional three-hole upper burner is used, at least two flamelets must remain lighted for the entire duration of the test, except that there may be intermittent flame extinguishment of all three flamelets for periods that do not exceed 3 seconds.

(9) A minimum of three specimens must be tested.

(f) Calculations.

(1) The calibration factor is calculated as follows:

$$K_h = \frac{(F_1 - F_0)}{(V_1 - V_0)} \times \frac{(210.8-22)k_{cal}}{mole} \times \frac{273}{T_a} \times \frac{P - P_V}{760} \times \frac{mole\,CH4\,STP}{22.41} \times \frac{WATT\,min}{.01433\,kcal} \times \frac{kw}{1000w}$$

F_o = flow of methane at baseline 1pm)

F_1 = higher pre-set flow of methane (1pm)

V_o = thermopile voltage at baseline (mv)

V_1 = thermopile voltage at higher flow (mv)

T_a = ambient temperature (K)

P = ambient pressure (mm Hg)

P_v = water vapour pressure (mm Hg)

(2) Heat release rates may be calculated from the reading of the thermopile output voltage at any instant of time as:

$$HRR = \frac{(V_m - V_b)K_h}{.02323\ m^2}$$

HRR = heat release rate (kw/m^2)

V_b = baseline voltage (mv)

V_m = measured thermopile voltage (mv)

K_h = calibration factor (kw/mv)

(3) The integral of the heat release rate is the total heat release as a function of time and is calculated by multiplying the rate by the data sampling frequency in minutes and summing the time from zero to two minutes.

(g) Criteria. The total positive heat release over the first two minutes of exposure for each of the three or more samples tested must be averaged, and the peak heat release rate for each of the samples must be averaged. The average total heat release must not exceed 65 kilowatt-minutes per square meter, and the average peak heat release rate must not exceed 65 kilowatts per square meter.

(h) Report. The test report must include the following for each specimen tested:

(1) Description of specimen.

(2) Radiant heat flux to the specimen expressed in W/cm^2.

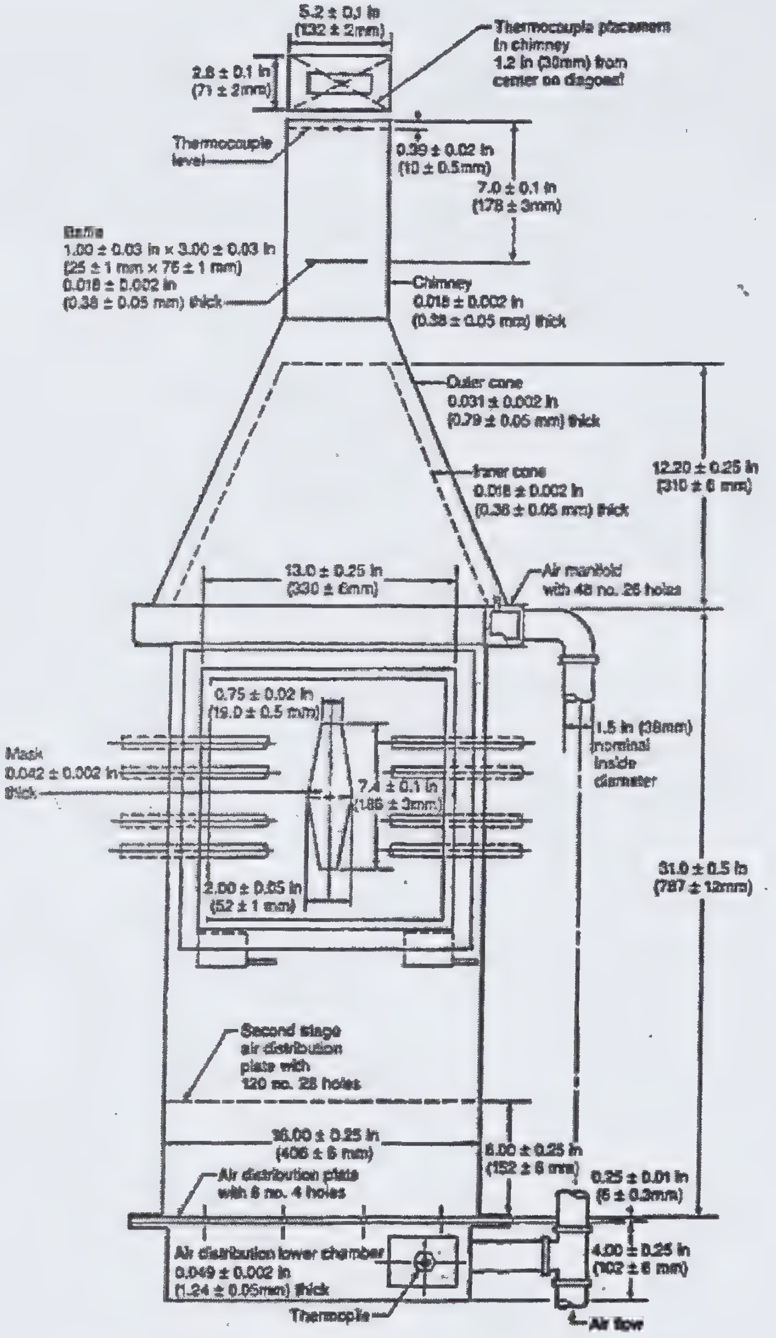
(3) Data giving release rates of heat (in kW/m^2) as a function of time, either graphically or tabulated at intervals no greater than 10 seconds. The calibration factor (k_n) must be recorded.

(4) If melting, sagging, delaminating, or other behaviour that affects the exposed surface area or the mode of burning occurs, these behaviours must be reported, together with the time at which such behaviours were observed.

(5) The peak heat release rate and the 2-minute integrated heat release rate must be reported.

(Change 525-2 (89-01-01))

(Change 525-7 (96-09-30))



Rate of Heat Release Apparatus

Figure - 1A

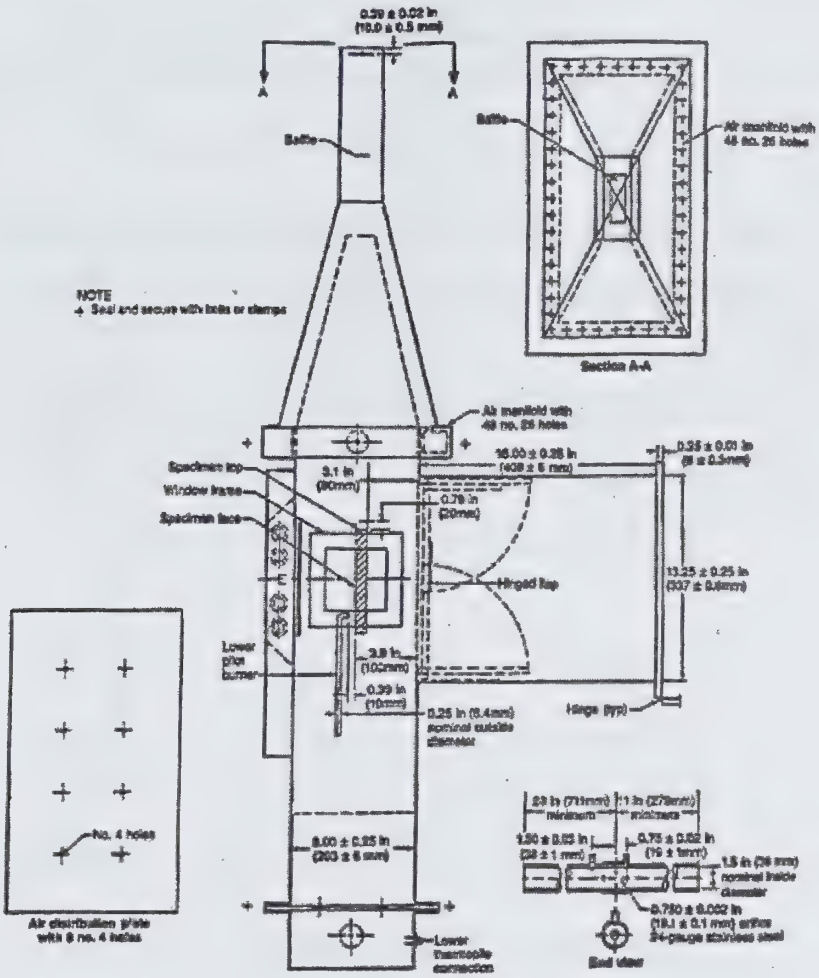
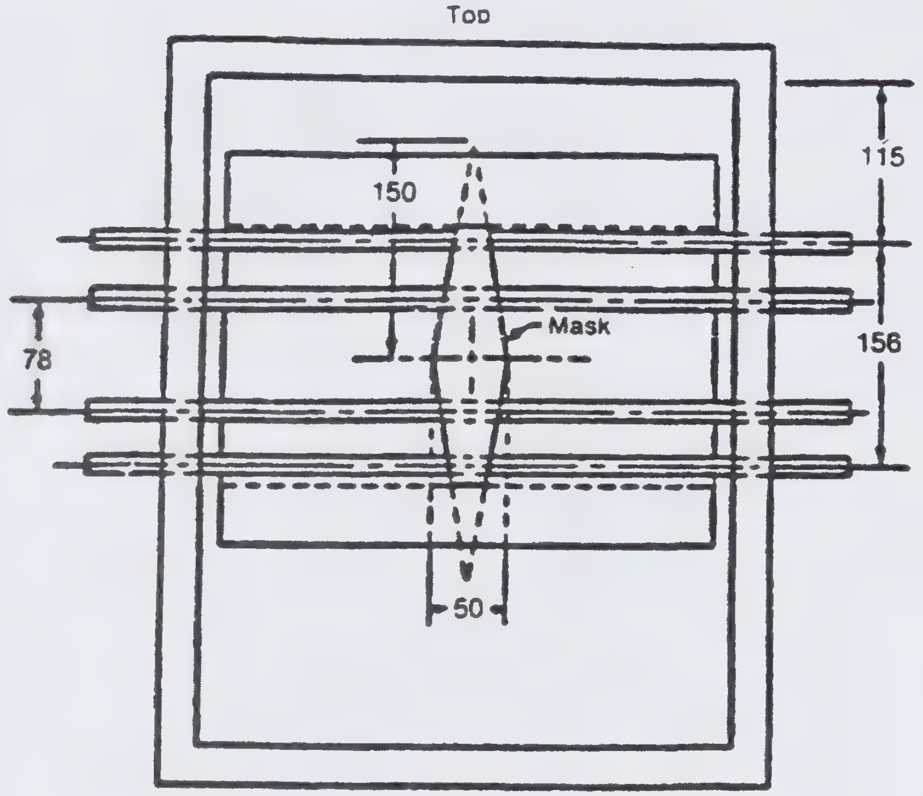
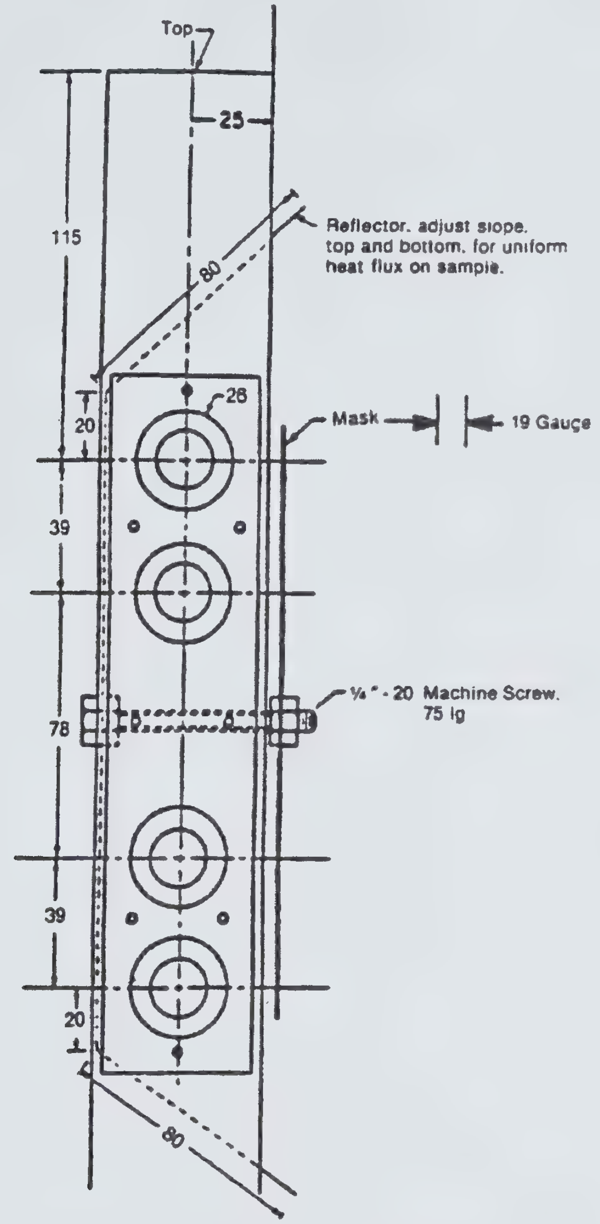


Figure 1B - Rate of Heat Release Apparatus



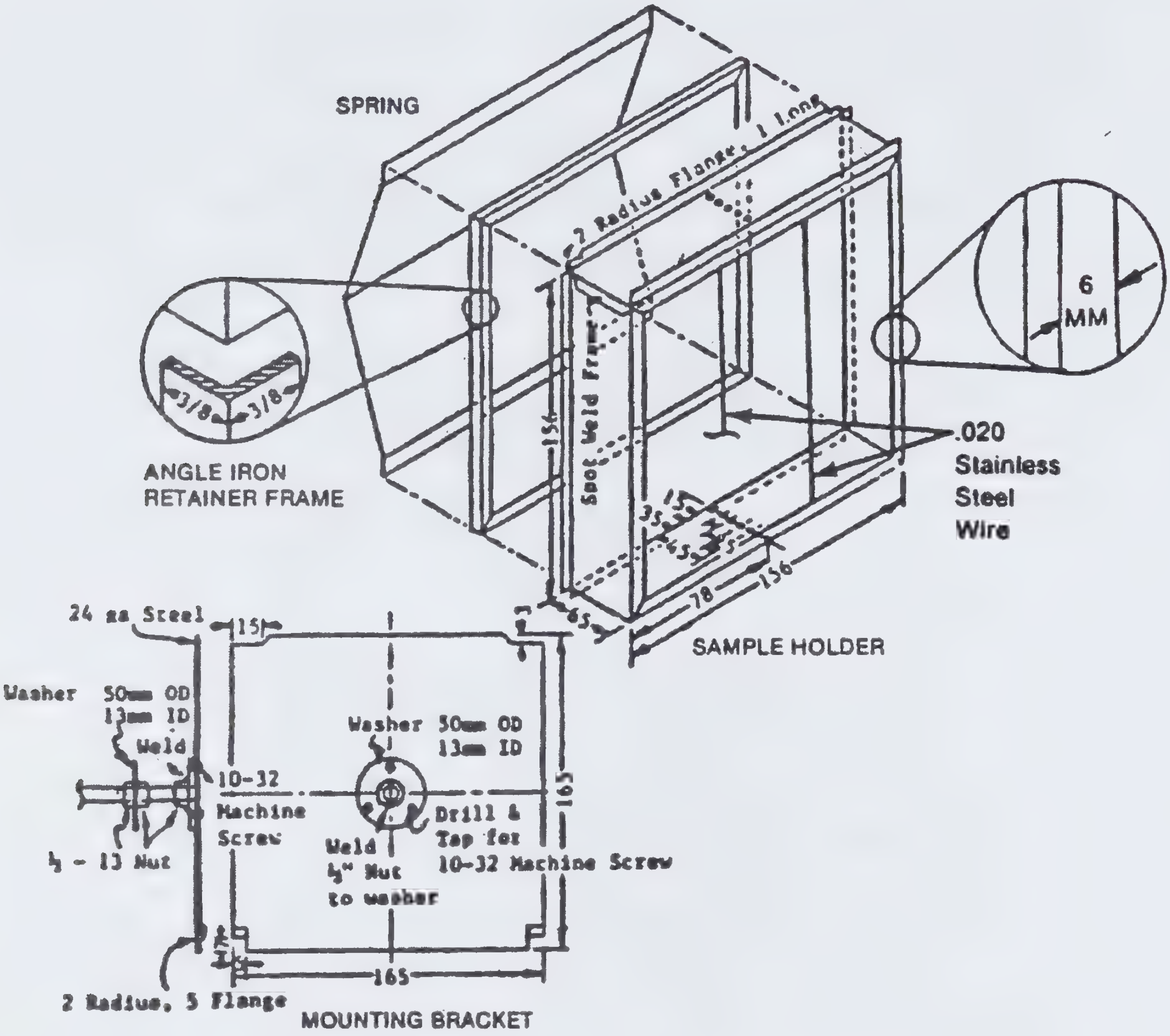
(Unless denoted otherwise all dimensions are in milimeters.)

[Figure 2A. "Globar" Radiant Panel]



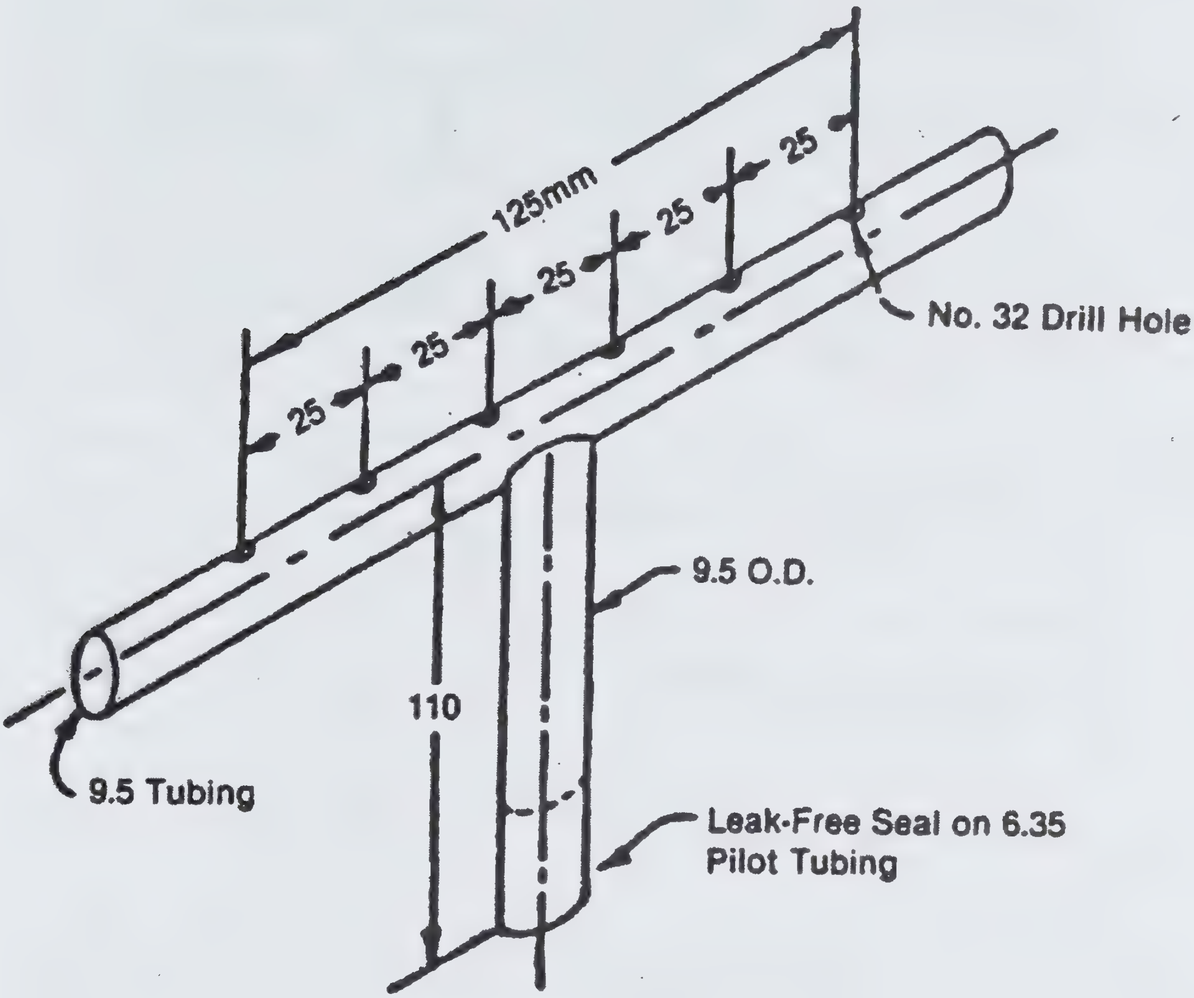
(Unless denoted otherwise all dimensions are in milimeters.)

[Figure 2B. "Globar" Radiant Panel]



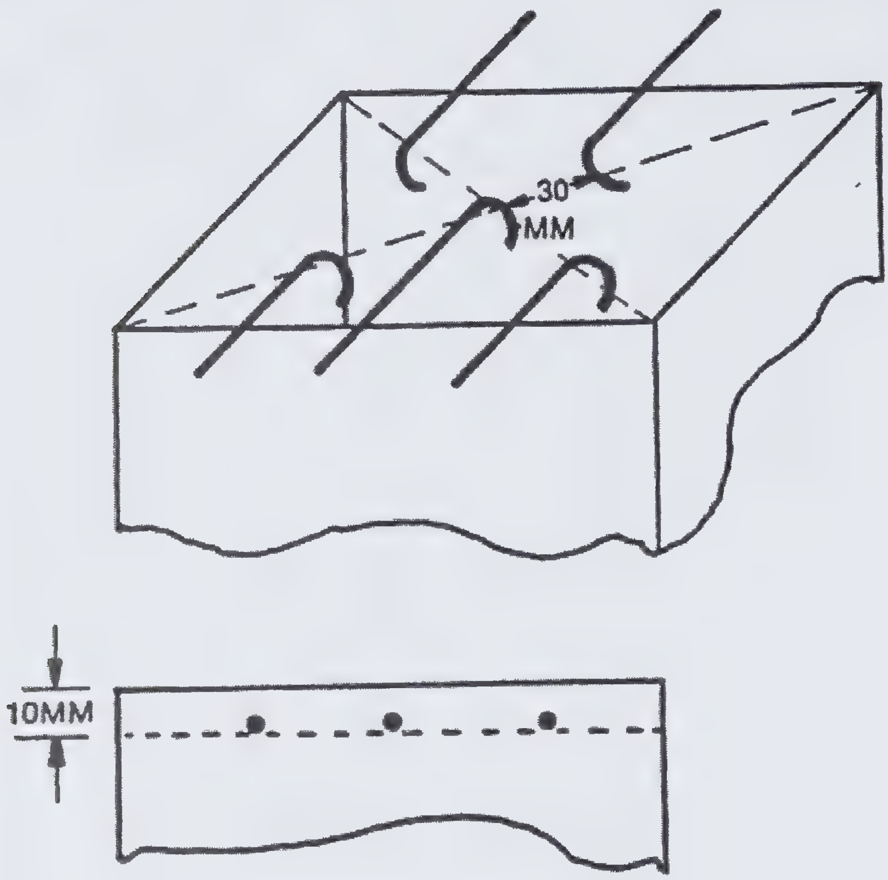
(Unless denoted otherwise, all dimensions are in millimeters.)

[Figure 3.]



(Unless denoted otherwise, all dimensions are in millimeters.)

[Figure 4.]



[Figure 5. Thermocouple Position]

(Change 525-1 (87-01-01))

Part V Test Method to Determine the Smoke Emission Characteristics of Cabin Materials

(a) Summary of Method. The specimens must be constructed, conditioned, and tested in the flaming mode in accordance with American Society of Testing and Materials (ASTM) Standard Test Method ASTM F814-83.

(b) Acceptance Criteria. The specific optical smoke density (D_s), which is obtained by averaging the reading obtained after 4 minutes with each of the three specimens, shall not exceed 200.

(Change 525-2 (89-01-01)

Part VI Test Method To Determine the Flammability and Flame Propagation Characteristics of Thermal/Acoustic Insulation Materials
(amended 2004/06/08)

Use this test method to evaluate the flammability and flame propagation characteristics of thermal/acoustic insulation when exposed to both a radiant heat source and a flame.

(a) Definitions.

"Flame propagation" means the furthest distance of the propagation of visible flame towards the far end of the test specimen, measured from the midpoint of the ignition source flame. Measure this distance after initially applying the ignition source and before all flame on the test specimen is extinguished. The measurement is not a determination of burn length made after the test.

"Radiant heat source" means an electric or air propane panel.

"Thermal/acoustic insulation" means a material or system of materials used to provide thermal and/or acoustic protection. Examples include fiberglass or other batting material encapsulated by a film covering and foams.

"Zero point" means the point of application of the pilot burner to the test specimen.

(b) Test apparatus.

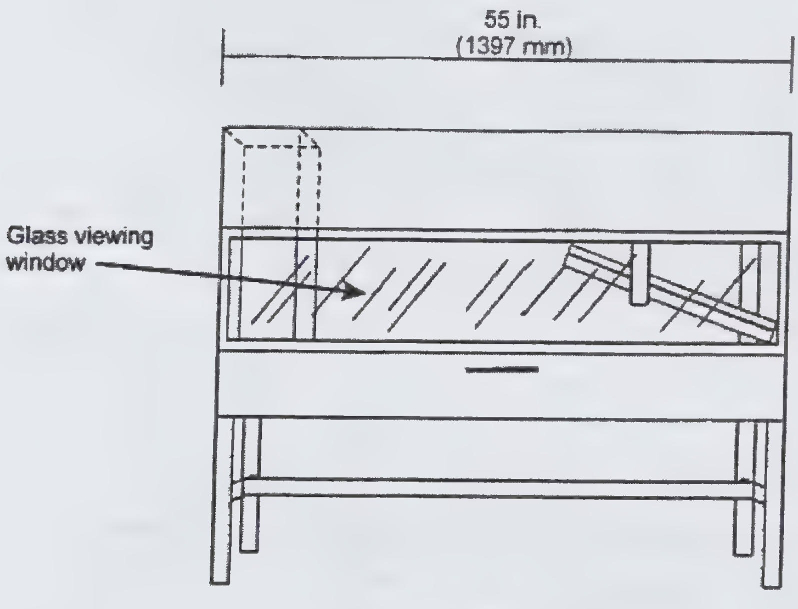


Figure 1 - Radiant Panel Test Chamber

(1) *Radiant panel test chamber*. Conduct tests in a radiant panel test chamber (see figure 1 above). Place the test chamber under an exhaust hood to facilitate clearing the chamber of smoke after each test. The radiant panel test chamber shall be an enclosure 55 inches (1397 mm) long by 19.5 (495 mm) deep by 28 (710 mm) to 30 inches (maximum)

(762 mm) above the test specimen. Insulate the sides, ends, and top with a fibrous ceramic insulation, such as Kaowool M™ board. On the front side, provide a 52 by 12-inch (1321 by 305 mm) draft-free, high-temperature, glass window for viewing the sample during testing. Place a door below the window to provide access to the movable specimen platform holder. The bottom of the test chamber shall be a sliding steel platform that has provision for securing the test specimen holder in a fixed and level position. The chamber shall have an internal chimney with exterior dimensions of 5.1 inches (129 mm) wide, by 16.2 inches (411 mm) deep by 13 inches (330 mm) high at the opposite end of the chamber from the radiant energy source. The interior dimensions shall be 4.5 inches (114 mm) wide by 15.6 inches (395 mm) deep. The chimney shall extend to the top of the chamber (see figure 2).

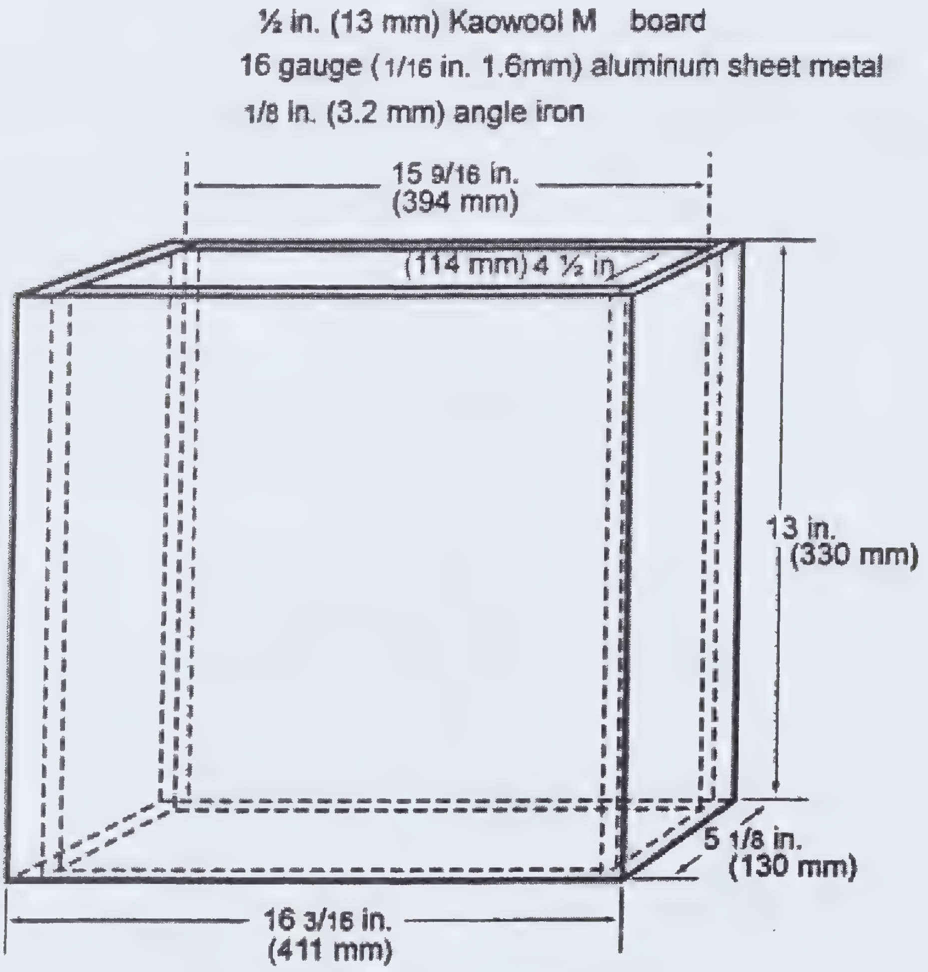


Figure 2 - Internal Chimney

(2) *Radiant heat source.* Mount the radiant heat energy source in a cast iron frame or equivalent. An electric panel shall have six, 3-inch wide emitter strips. The emitter strips

shall be perpendicular to the length of the panel. The panel shall have a radiation surface of 12 7/8 by 18 ½ inches (327 by 470 mm). The panel shall be capable of operating at temperatures up to 1300° F (704° C). An air propane panel shall be made of a porous refractory material and have a radiation surface of 12 by 18 inches (305 by 457 mm). The panel shall be capable of operating at temperatures up to 1,500° F (816° C). See figures 3a and 3b.

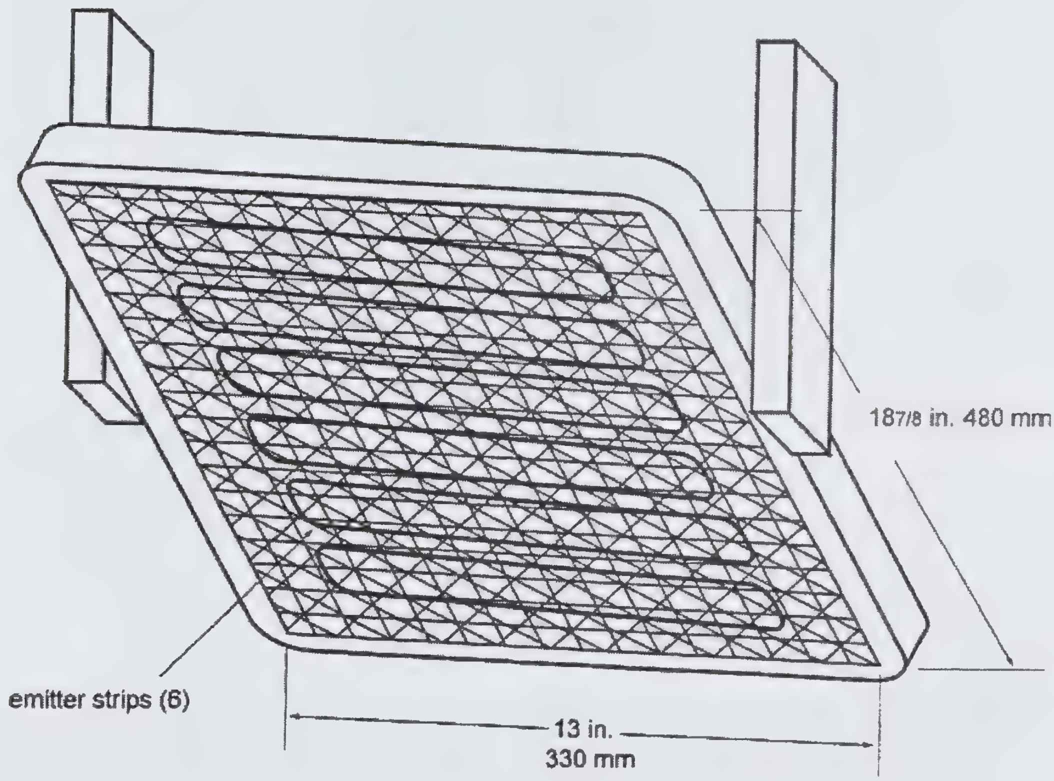


Figure 3a – Electric Panel

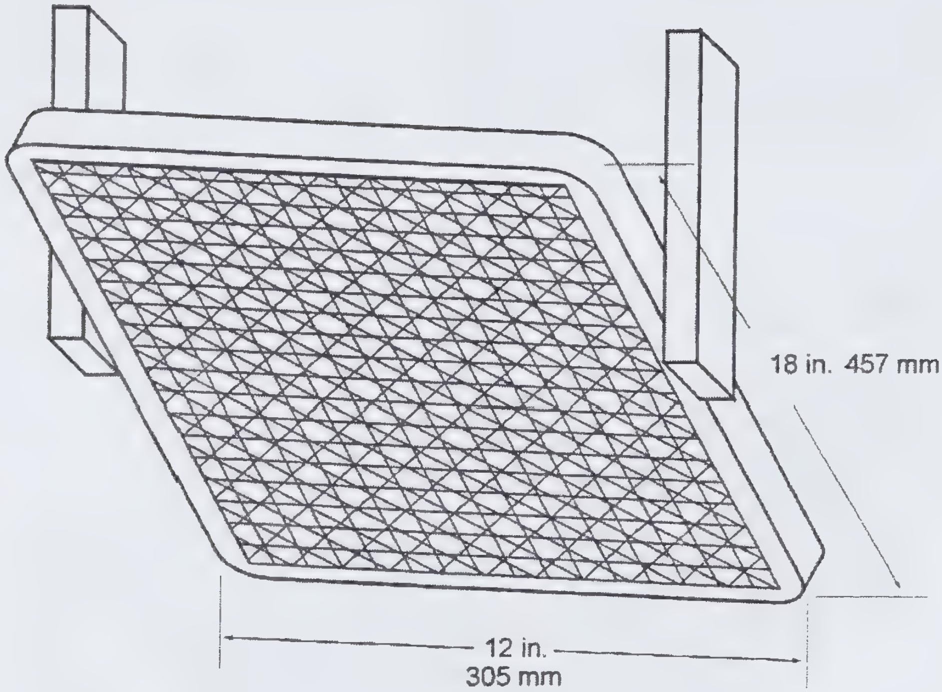


Figure 3b – Air Propane Radiant Panel

(i) *Electric radiant panel.* The radiant panel shall be 3-phase and operate at 208 volts. A single-phase, 240 volt panel is also acceptable. Use a solid-state power controller and microprocessor-based controller to set the electric panel operating parameters.

(ii) *Gas radiant panel.* Use propane (liquid petroleum gas—2.1 UN 1075) for the radiant panel fuel. The panel fuel system shall consist of a venturi-type aspirator for mixing gas and air at approximately atmospheric pressure. Provide suitable instrumentation for monitoring and controlling the flow of fuel and air to the panel. Include an air flow gauge, an air flow regulator, and a gas pressure gauge.

(iii) *Radiant panel placement.* Mount the panel in the chamber at 30° to the horizontal specimen plane, and 7 1/2 inches above the zero point of the specimen.

(3) *Specimen holding system.*

(i) The sliding platform serves as the housing for test specimen placement. Brackets may be attached (via wing nuts) to the top lip of the platform in order to accommodate various thicknesses of test specimens. Place the test specimens on a sheet of Kaowool M™ board or 1260 Standard Board (manufactured by Thermal Ceramics and available in Europe), or equivalent, either resting on the bottom lip of the sliding platform or on the base of the brackets. It may be necessary to use multiple sheets of material based on the thickness of the test specimen (to meet the sample height requirement). Typically, these non-combustible sheets of material are available in ¼ inch (6 mm) thicknesses. See figure 4. A sliding platform that is deeper than the 2-inch (50.8mm) platform shown in figure 4 is also acceptable as long as the sample height requirement is met.

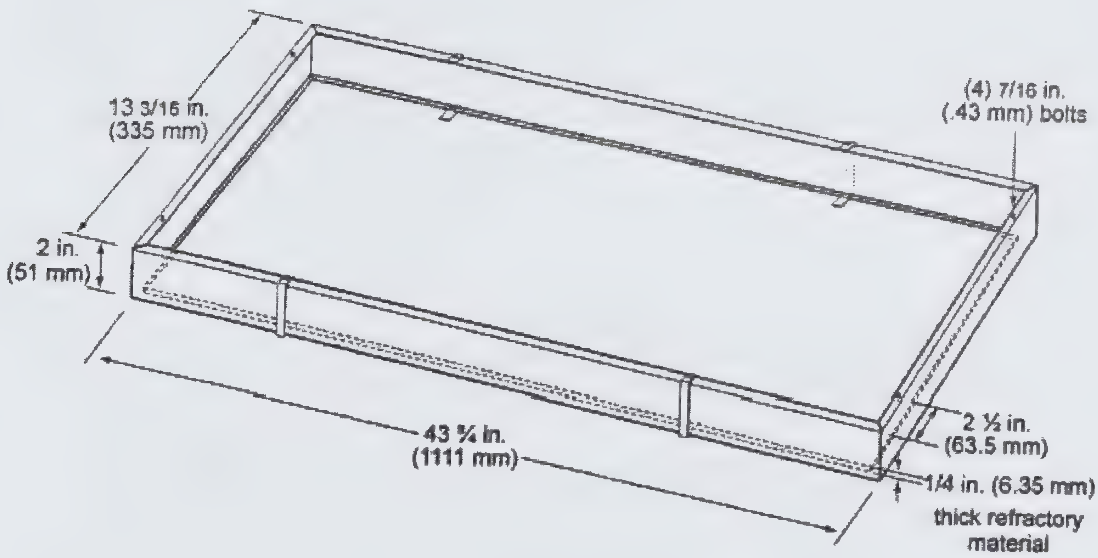


Figure 4 - Sliding Platform

(ii) Attach a ½ inch (13 mm) piece of Kaowool M™ board or other high temperature material measuring 41 ½ by 8 ¼ inches (1054 by 210 mm) to the back of the platform. This board serves as a heat retainer and protects the test specimen from excessive preheating. The height of this board shall not impede the sliding platform movement (in and out of the test chamber). If the platform has been fabricated such that the back side of the platform is high enough to prevent excess

preheating of the specimen when the sliding platform is out, a retainer board is not necessary.

(iii) Place the test specimen horizontally on the non- combustible board(s). Place a steel retaining/securing frame fabricated of mild steel, having a thickness of 1/8 inch (3.2 mm) and overall dimensions of 23 by 13 1/8 inches (584 by 333 mm) with a specimen opening of 19 by 10 3/4 inches (483 by 273 mm) over the test specimen. The front, back, and right portions of the top flange of the frame shall rest on the top of the sliding platform, and the bottom flanges shall pinch all 4 sides of the test specimen. The right bottom flange shall be flush with the sliding platform. See figure 5.

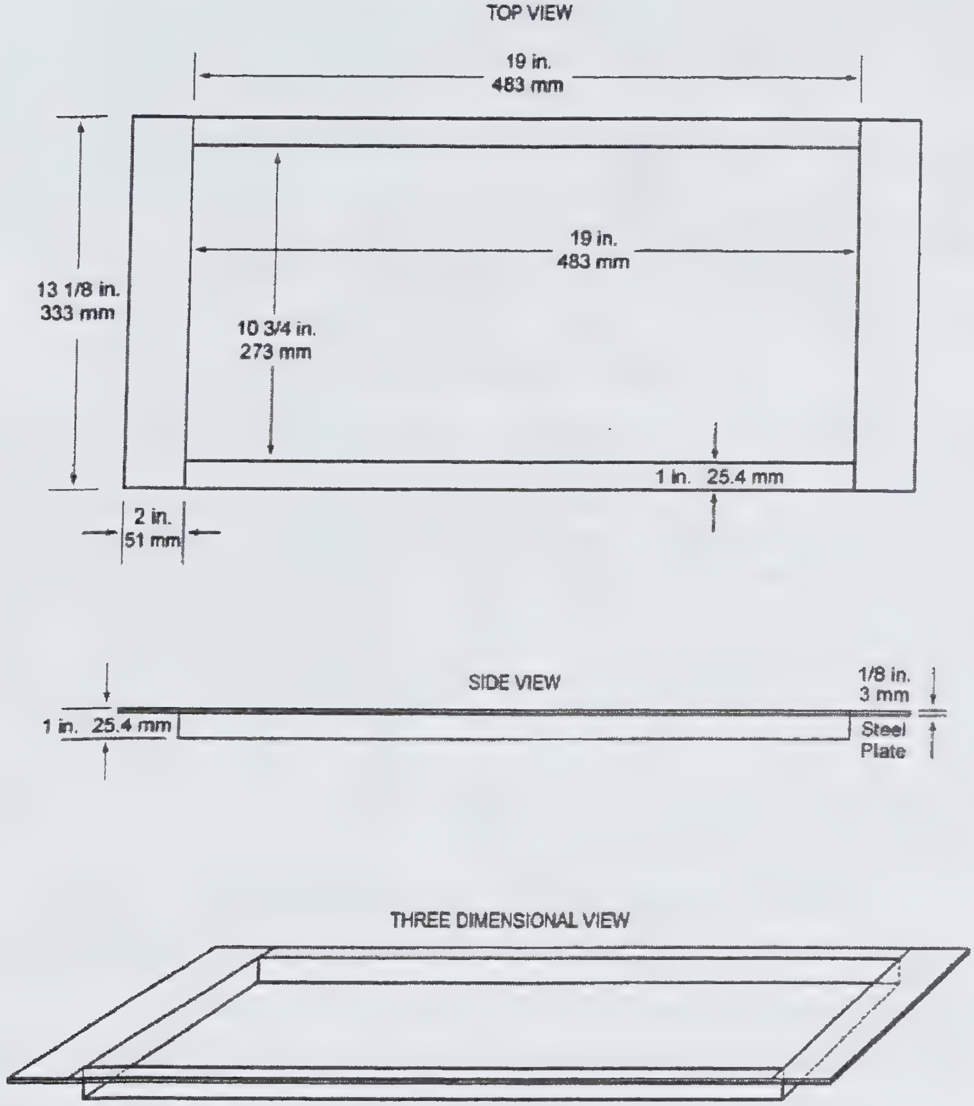


Figure 5: 3 views

(4) *Pilot Burner*. The pilot burner used to ignite the specimen shall be a Bernzomatic™ commercial propane venturi torch with an axially symmetric burner tip and a propane supply tube with an orifice diameter of 0.006 inches (0.15 mm). The length of the burner tube shall be 2 7/8 inches (71 mm). The propane flow shall be adjusted via gas pressure through an in-line regulator to produce a blue inner cone length of ¾ inch (19 mm). A ¾ inch (19 mm) guide (such as a thin strip of metal) may be soldered to the top of the burner to aid in setting the flame height. The overall flame length shall be approximately 5 inches long (127 mm). Provide a way to move the burner out of the ignition position so that the flame is horizontal and at least 2 inches (50 mm) above the specimen plane. See figure 6.

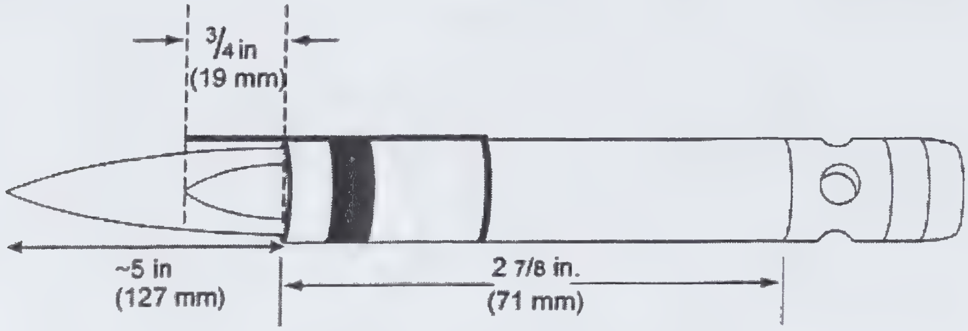


Figure 6 – Propane Pilot Burner

(5) *Thermocouples*. Install a 24 American Wire Gauge (AWG) Type K (Chromel-Alumel) thermocouple in the test chamber for temperature monitoring. Insert it into the chamber through a small hole drilled through the back of the chamber. Place the thermocouple so that it extends 11 inches (279 mm) out from the back of the chamber wall, 11 ½ inches (292 mm) from the right side of the chamber wall, and is 2 inches (51 mm) below the radiant panel. The use of other thermocouples is optional.

(6) *Calorimeter*. The calorimeter shall be a one-inch cylindrical water-cooled, total heat flux density, foil type Gardon Gage that has a range of 0 to 5 BTU/ft ^{2} - second (0 to 5.7 Watts/cm^2).

(7) Calorimeter calibration specification and procedure.

(i) *Calorimeter specification.*

(A) Foil diameter shall be 0.25 +/-0.005 inches (6.35 +/-0.13 mm).

(B) Foil thickness shall be 0.0005 +/-0.0001 inches (0.013 +/- 0.0025 mm).

(C) Foil material shall be thermocouple grade Constantan.

(D) Temperature measurement shall be a Copper Constantan thermocouple.

(E) The copper centre wire diameter shall be 0.0005 inches (0.013 mm).

(F) The entire face of the calorimeter shall be lightly coated with “Black Velvet” paint having an emissivity of 96 or greater.

(ii) *Calorimeter calibration.*

(A) The calibration method shall be by comparison to a like standardized transducer.

(B) The standardized transducer shall meet the specifications given in paragraph VI(b)(6) of this appendix.

(C) Calibrate the standard transducer against a primary standard traceable to the National Institute of Standards and Technology (NIST).

(D) The method of transfer shall be a heated graphite plate.

(E) The graphite plate shall be electrically heated, have a clear surface area on each side of the plate of at least 2 by 2 inches (51 by 51 mm), and be 1/8 inch +/- 1/16 inch thick (3.2 +/- 1.6 mm).

(F) Centre the 2 transducers on opposite sides of the plates at equal distances from the plate.

(G) The distance of the calorimeter to the plate shall be no less than 0.0625 inches (1.6 mm), nor greater than 0.375 inches (9.5 mm).

(H) The range used in calibration shall be at least 0-3.5 BTU/ft^2 - second (0-3.9 Watts/cm^2) and no greater than 0-5.7 BTU/ft^2 - second (0-6.4 Watts/cm^2).

(I) The recording device used shall record the 2 transducers simultaneously or at least within 1/10 of each other.

(8) *Calorimeter fixture*. With the sliding platform pulled out of the chamber, install the calorimeter holding frame and place a sheet of non-combustible material in the bottom of the sliding platform adjacent to the holding frame. This will prevent heat losses during calibration. The frame shall be 13 1/8 inches (333 mm) deep (front to back) by 8 inches (203 mm) wide and shall rest on the top of the sliding platform. It shall be fabricated of 1/8 inch (3.2 mm) flat stock steel and have an opening that accommodates a ½ inch (12.7 mm) thick piece of refractory board, which is level with the top of the sliding platform. The board shall have three 1-inch (25.4 mm) diameter holes drilled through the board for calorimeter insertion. The distance to the radiant panel surface from the centerline of the first hole ("zero" position) shall be 7 ½ +/- 1/8 inches (191 +/-3 mm). The distance between the centerline of the first hole to the centerline of the second hole shall be 2 inches (51 mm). It shall also be the same distance from the centerline of the second hole to the centerline of the third hole. See figure 7. A calorimeter holding frame that differs in construction is acceptable as long as the height from the centerline of the first hole to the radiant panel and the distance between holes is the same as described in this paragraph.

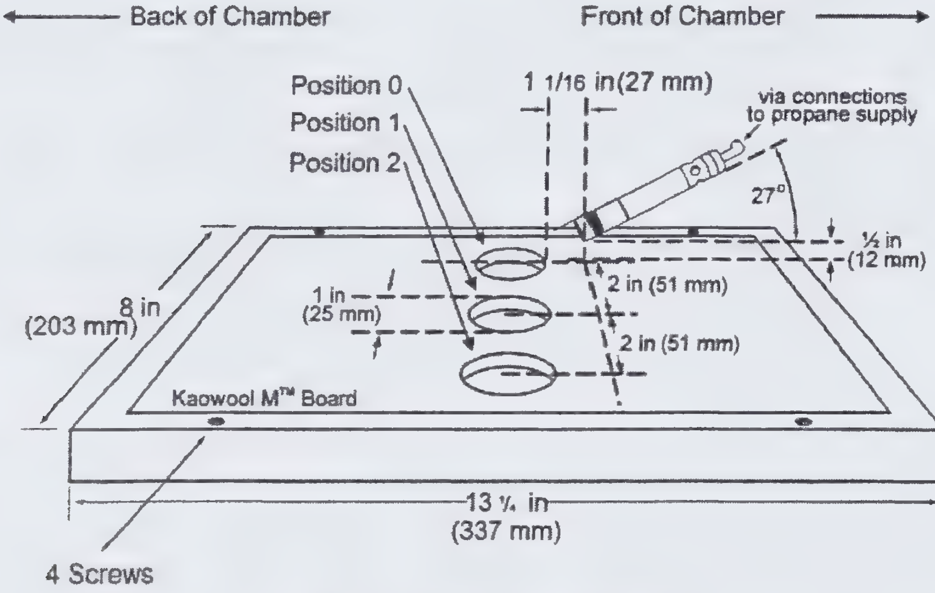


Figure 7 - Calorimeter Holding Frame

(9) *Instrumentation*. Provide a calibrated recording device with an appropriate range or a computerized data acquisition system to measure and record the outputs of the calorimeter and the thermocouple. The data acquisition system shall be capable of recording the calorimeter output every second during calibration.

(10) *Timing device*. Provide a stopwatch or other device, accurate to +/- 1 second/hour, to measure the time of application of the pilot burner flame.

(c) Test specimens.

(1) *Specimen preparation*. Prepare and test a minimum of three test specimens. If an oriented film cover material is used, prepare and test both the warp and fill directions.

(2) *Construction*. Test specimens shall include all materials used in construction of the insulation (including batting, film, scrim, tape etc.). Cut a piece of core material such as foam or fiberglass, and cut a piece of film cover material (if used) large enough to cover the core material. Heat sealing is the preferred method of preparing fiberglass samples, since they can be made without compressing the fiberglass ("box sample"). Cover materials that are not heat sealable may be stapled, sewn, or taped as long as the cover material is over-cut enough to be drawn down the sides without compressing the core material. The fastening means should be as continuous as possible along the length of the seams. The specimen thickness shall be of the same thickness as installed in the aeroplane.

(3) *Specimen Dimensions*. To facilitate proper placement of specimens in the sliding platform housing, cut non-rigid core materials, such as fiberglass, 12 ½ inches (318mm) wide by 23 inches (584mm) long. Cut rigid materials, such as foam, 11 ½ + /- ¼ inches (292 mm +/- 6mm) wide by 23 inches (584mm) long in order to fit properly in the sliding platform housing and provide a flat, exposed surface equal to the opening in the housing.

(d) Specimen conditioning.

Condition the test specimens at 70 +/- 5° F (21 +/- 2° C) and 55% +/- 10% relative humidity, for a minimum of 24 hours prior to testing.

(e) Apparatus Calibration.

(1) With the sliding platform out of the chamber, install the calorimeter holding frame. Push the platform back into the chamber and insert the calorimeter into the first hole ("zero" position). See figure 7. Close the bottom door located below the sliding platform. The distance from the centerline of the calorimeter to the radiant panel surface at this point shall be 7 ½ inches +/- 1/8 (191 mm +/- 3). Prior to igniting the radiant panel, ensure that the calorimeter face is clean and that there is water running through the calorimeter.

(2) Ignite the panel. Adjust the fuel/air mixture to achieve 1.5 BTU/ft^2 - second +/- 5% (1.7 Watts/cm^2 +/- 5%) at the "zero" position. If using an electric panel, set the power controller to achieve the proper heat flux. Allow the unit to reach steady state (this may take up to 1 hour). The pilot burner shall be off and in the down position during this time.

(3) After steady-state conditions have been reached, move the calorimeter 2 inches (51 mm) from the "zero" position (first hole) to position 1 and record the heat flux. Move the calorimeter to position 2 and record the heat flux. Allow enough time at each position for the calorimeter to stabilize. Table 1 depicts typical calibration values at the three positions.

Table 1 - Calibration Table

Position	BTU/ft^2 - second	Watts/cm^2
"Zero" Position	1.5	1.7
Position 1	1.51-1.50-1.49	1.71-1.70-1.69
Position 2	1.43-1.44	1.62-1.63

(4) Open the bottom door, remove the calorimeter and holder fixture. Use caution as the fixture is very hot.

(f) Test Procedure.

(1) Ignite the pilot burner. Ensure that it is at least 2 inches (51 mm) above the top of the platform. The burner shall not contact the specimen until the test begins.

(2) Place the test specimen in the sliding platform holder. Ensure that the test sample surface is level with the top of the platform. At "zero" point, the specimen surface shall be 7½ inches +/- 1/8 inch (191 mm +/- 3) below the radiant panel.

(3) Place the retaining/securing frame over the test specimen. It may be necessary (due to compression) to adjust the sample (up or down) in order to maintain the distance from the sample to the radiant panel (7 ½ inches +/- 1/8 inch (191 mm+/- 3) at "zero" position). With film/fiberglass assemblies, it is critical to make a slit in the film cover to purge any air inside. This allows the operator to maintain the proper test specimen position (level with the top of the platform) and to allow ventilation of gases during testing. A longitudinal slit, approximately 2 inches (51 mm) in length, shall be centered 3 inches +/- ½ inch (76 mm +/-

13 mm) from the left flange of the securing frame. A utility knife is acceptable for slitting the film cover.

(4) Immediately push the sliding platform into the chamber and close the bottom door.

(5) Bring the pilot burner flame into contact with the centre of the specimen at the "zero" point and simultaneously start the timer. The pilot burner shall be at a 27° angle with the sample and be approximately ½ inch (12 mm) above the sample. See figure 7. A stop, as shown in figure 8, allows the operator to position the burner correctly each time.

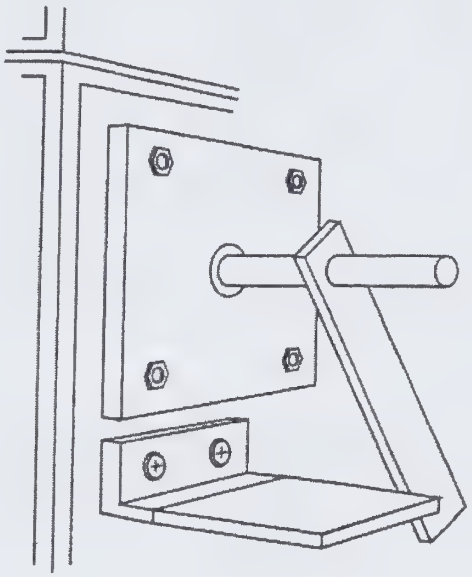


Figure 8 - Propane Burner Stop

(6) Leave the burner in position for 15 seconds and then remove to a position at least 2 inches (51 mm) above the specimen.

(g) Report.

(1) Identify and describe the test specimen.

(2) Report any shrinkage or melting of the test specimen.

(3) Report the flame propagation distance. If this distance is less than 2 inches, report this as a pass (no measurement required).

(4) Report the after-flame time.

(h) Requirements.

(1) There shall be no flame propagation beyond 2 inches (51 mm) to the left of the centerline of the pilot flame application.

(2) The flame time after removal of the pilot burner may not exceed 3 seconds on any specimen.

Part VII Test Method To Determine the Burnthrough Resistance of Thermal/Acoustic Insulation Materials

(amended 2004/06/08)

Use the following test method to evaluate the burnthrough resistance characteristics of aircraft thermal/acoustic insulation materials when exposed to a high intensity open flame.

(a) Definitions.

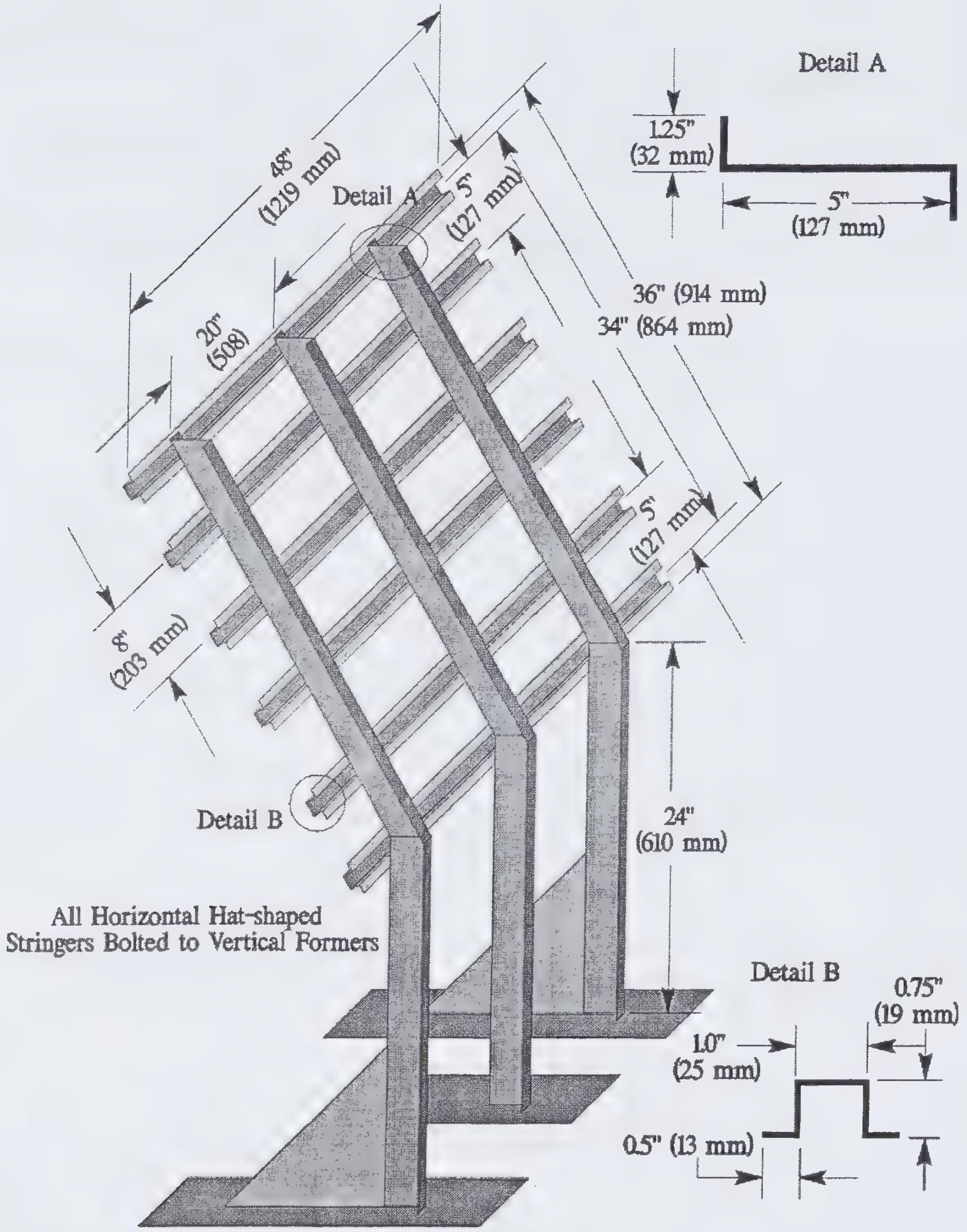
"Burnthrough time" means the time, in seconds, for the burner flame to penetrate the test specimen, and/or the time required for the heat flux to reach 2.0 BTU/ft^2 - second (2.27 W/cm^2) on the inboard side, at a distance of 12 inches (30.5 cm) from the front surface of the insulation blanket test frame, whichever is sooner. The burnthrough time is measured at the inboard side of each of the insulation blanket specimens.

"Insulation blanket specimen" means one of two specimens positioned in either side of the test rig, at an angle of 30° with respect to vertical.

"Specimen set" means two insulation blanket specimens. Both specimens shall represent the same production insulation blanket construction and materials, proportioned to correspond to the specimen size.

(b) Apparatus.

(1) The arrangement of the test apparatus is shown in figures 1 and 2 and shall include the capability of swinging the burner away from the test specimen during warm-up.



All Material 0.125" (3mm) Thickness Except Central Former, 0.250" (6mm) Thick

Figure 1 – Burnthrough Test Apparatus Specimen Holder

(2) *Test burner*. The test burner shall be a modified gun-type such as the Park Model DPL 3400. Flame characteristics are highly dependent on actual burner setup. Parameters such as fuel pressure, nozzle depth, stator position, and intake airflow shall be properly adjusted to achieve the correct flame output.

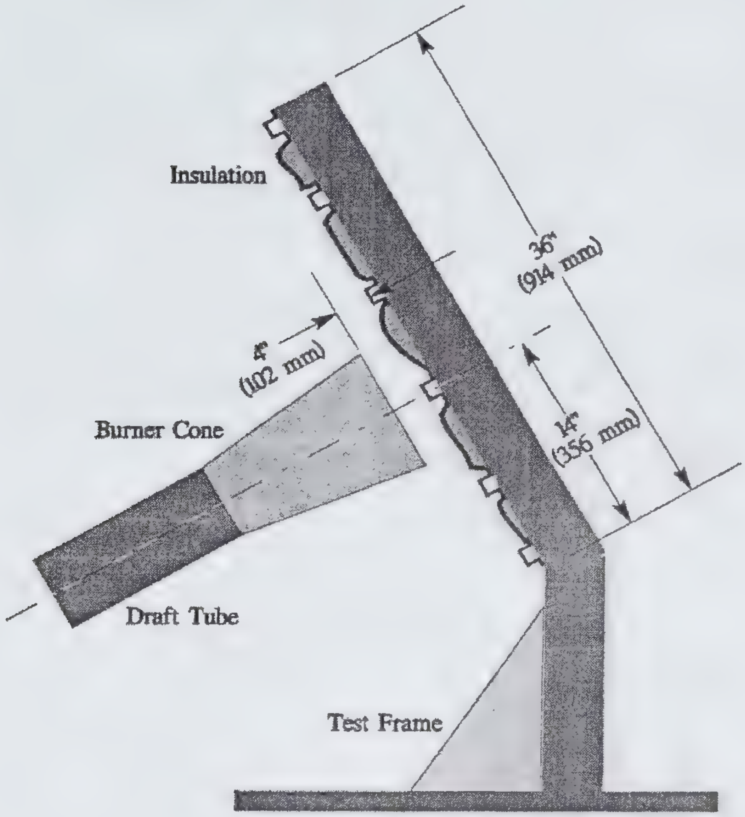


Figure 2 – Burnthrough Test Apparatus

(i) *Nozzle.* A nozzle shall maintain the fuel pressure to yield a nominal 6.0 gal/hr (0.378 L/min) fuel flow. A Monarch-manufactured 80° PL (hollow cone) nozzle nominally rated at 6.0 gal/hr at 100 lb/in^2 (0.71 MPa) delivers a proper spray pattern.

(ii) *Fuel Rail.* The fuel rail shall be adjusted to position the fuel nozzle at a depth of 0.3125 inch (8 mm) from the end plane of the exit stator, which shall be mounted in the end of the draft tube.

(iii) *Internal Stator.* The internal stator, located in the middle of the draft tube, shall be positioned at a depth of 3.75 inches (95 mm) from the tip of the fuel nozzle. The stator shall also be positioned such that the integral igniters are located at an angle midway between the 10 and 11 o'clock position, when viewed looking into the draft tube. Minor deviations to the igniter angle are acceptable if the temperature and heat flux requirements conform to the requirements of paragraph VII (e) of this appendix.

(iv) *Blower Fan.* The cylindrical blower fan used to pump air through the burner shall measure 5.25 inches (133 mm) in diameter by 3.5 inches (89 mm) in width.

(v) *Burner cone*. Install a 12 +/- 0.125-inch (305 +/-3 mm) burner extension cone at the end of the draft tube. The cone shall have an opening 6 +/- 0.125 inch (152 +/- 3 mm) high and 11 +/- 0.125 inch (280 +/- 3 mm) wide (see figure 3).

(vi) *Fuel*. Use JP-8, Jet A, or their international equivalent, at a flow rate of 6.0 +/- 0.2 gal/hr (0.378 +/- 0.0126 L/min). If this fuel is unavailable, ASTM K2 fuel (Number 2 grade kerosene) or ASTM D2 fuel (Number 2 grade fuel oil or Number 2 diesel fuel) are acceptable if the nominal fuel flow rate, temperature, and heat flux measurements conform to the requirements of paragraph VII (e) of this appendix.

(vii) *Fuel pressure regulator*. Provide a fuel pressure regulator, adjusted to deliver a nominal 6.0 gal/hr (0.378 L/min) flow rate. An operating fuel pressure of 100 lb/in^2 (0.71 MPa) for a nominally rated 6.0 gal/hr 80° spray angle nozzle (such as a PL type) delivers 6.0 +/- 0.2 gal/hr (0.378 +/- 0.0126 L/min).

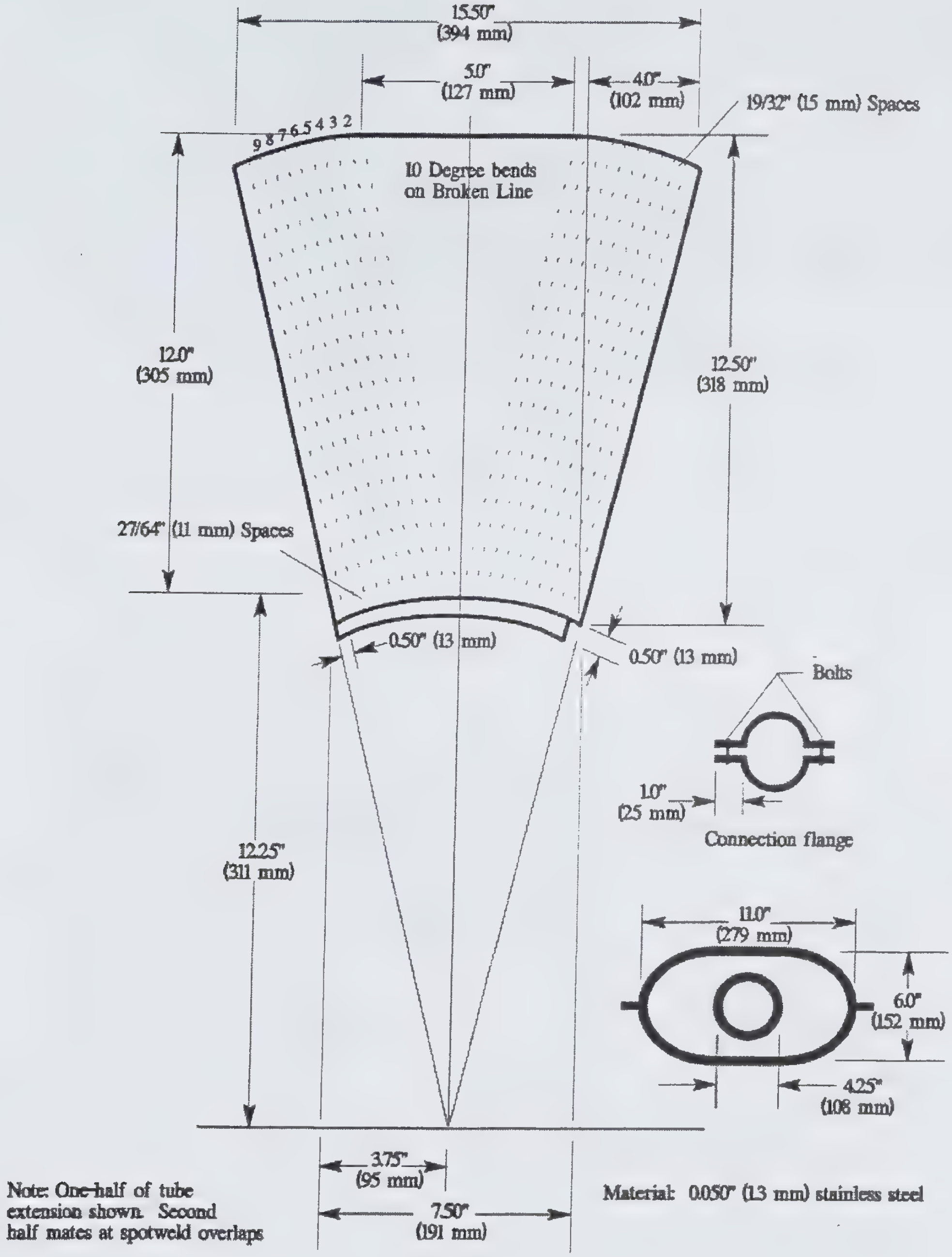


Figure 3 – Burner Draft Tube Extension Cone Diagram

(3) *Calibration rig and equipment.*

(i) Construct individual calibration rigs to incorporate a calorimeter and thermocouple rake for the measurement of heat flux and temperature. Position the calibration rigs to allow movement of the burner from the test rig position to either the heat flux or temperature position with minimal difficulty.

(ii) *Calorimeter*. The calorimeter shall be a total heat flux, foil type Gardon Gage of an appropriate range such as 0 - 20 BTU/ft^2 - second (0 - 22.7 W/cm^2), accurate to +/- 3% of the indicated reading. The heat flux calibration method shall be in accordance with paragraph VI (b)(7) of this appendix.

(iii) *Calorimeter mounting*. Mount the calorimeter in a 6 by 12 +/- 0.125 inch (152 by 305 +/- 3 mm) by 0.75 +/- 0.125 inch (19 mm +/ -3 mm) thick insulating block which is attached to the heat flux calibration rig during calibration (figure 4). Monitor the insulating block for deterioration and replace it when necessary. Adjust the mounting as necessary to ensure that the calorimeter face is parallel to the exit plane of the test burner cone.

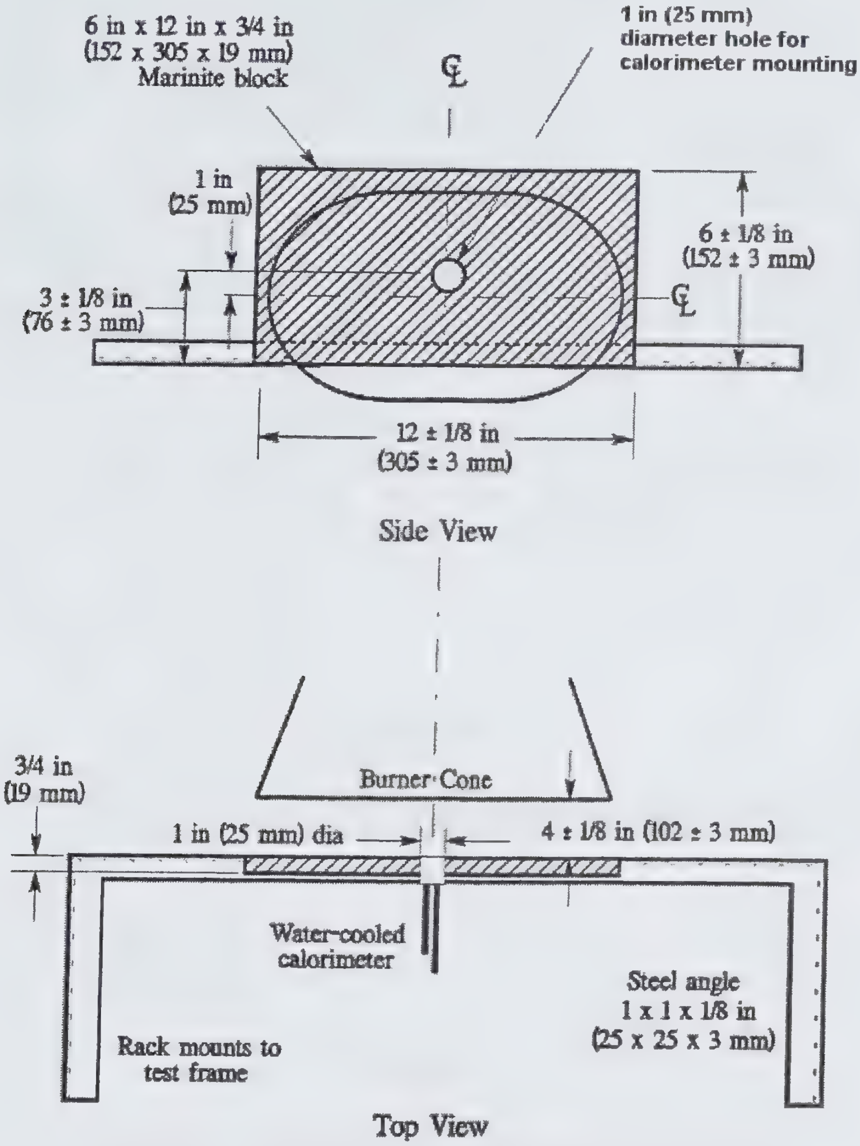


Figure 4 – Calorimeter Position Relative to Burner Cone

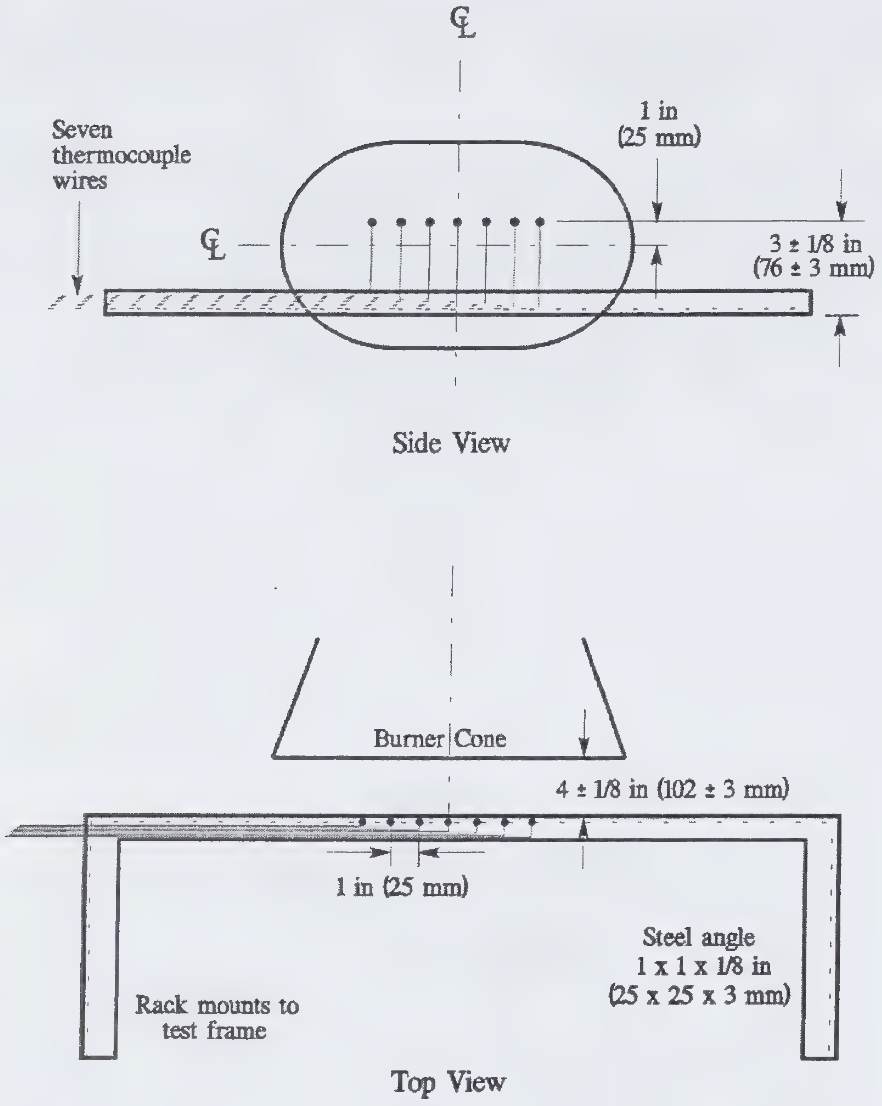


Figure 5 – Thermocouple Rake Position Relative to Burner Cone

(iv) *Thermocouples*. Provide seven 1/8-inch (3.2 mm) ceramic packed, metal sheathed, type K (Chromel-alumel), grounded junction thermocouples with a nominal 24 American Wire Gauge (AWG) size conductor for calibration. Attach the thermocouples to a steel angle bracket to form a thermocouple rake for placement in the calibration rig during burner calibration (figure 5).

(v) *Air velocity meter*. Use a vane-type air velocity meter to calibrate the velocity of air entering the burner. An Omega Engineering Model HH30A is satisfactory. Use a suitable adapter to attach the measuring device to the inlet side of the burner to prevent air from entering the burner other than through the measuring device,

which would produce erroneously low readings. Use a flexible duct, measuring 4 inches wide (102 mm) by 20 feet long (6.1 meters), to supply fresh air to the burner intake to prevent damage to the air velocity meter from ingested soot. An optional airbox permanently mounted to the burner intake area can effectively house the air velocity meter and provide a mounting port for the flexible intake duct.

(4) *Test specimen mounting frame*. Make the mounting frame for the test specimens of 1/8-inch (3.2 mm) thick steel as shown in figure 1, except for the centre vertical former, which should be 1/ 4-inch (6.4 mm) thick to minimize warpage. The specimen mounting frame stringers (horizontal) should be bolted to the test frame formers (vertical) such that the expansion of the stringers will not cause the entire structure to warp. Use the mounting frame for mounting the two insulation blanket test specimens as shown in figure 2.

(5) *Backface calorimeters*. Mount two total heat flux Gardon type calorimeters behind the insulation test specimens on the back side (cold) area of the test specimen mounting frame as shown in figure 6. Position the calorimeters along the same plane as the burner cone centerline, at a distance of 4 inches (102 mm) from the vertical centerline of the test frame.

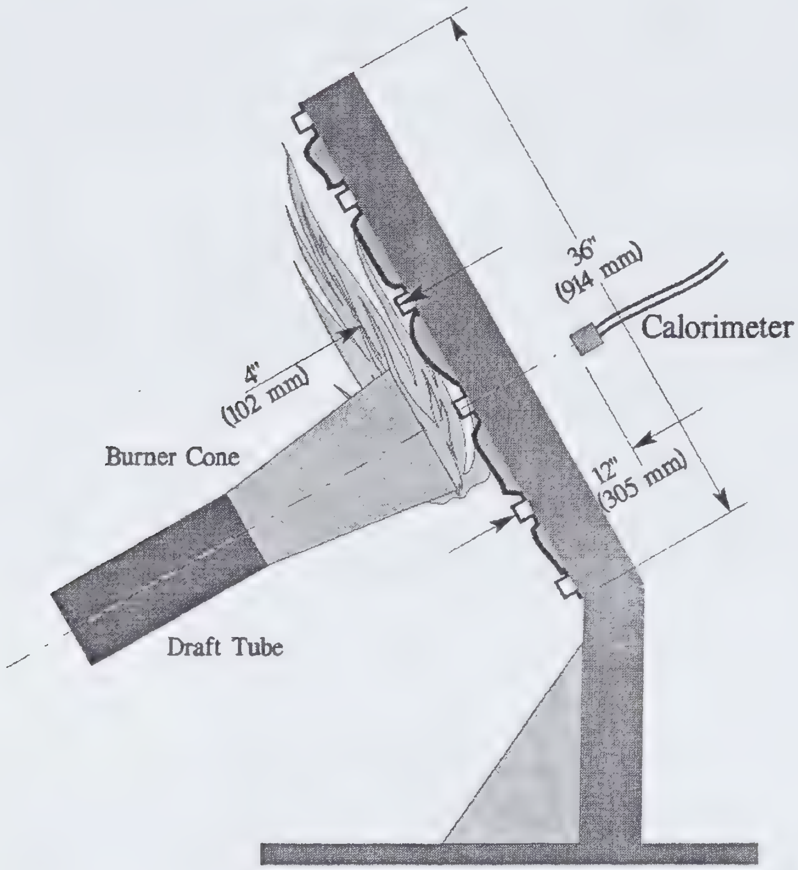


Figure 6 – Position of Backface Calorimeters Relative to Test Specimen Frame

(i) The calorimeters shall be a total heat flux, foil type Gardon Gage of an appropriate range such as 0-5 BTU/ft^2 - second (0 - 5.7 W/cm^2), accurate to +/- 3% of the indicated reading. The heat flux calibration method shall comply with paragraph VI (b)(7) of this appendix.

(6) *Instrumentation.* Provide a recording potentiometer or other suitable calibrated instrument with an appropriate range to measure and record the outputs of the calorimeter and the thermocouples.

(7) *Timing device.* Provide a stopwatch or other device, accurate to +/- 1%, to measure the time of application of the burner flame and burnthrough time.

(8) *Test chamber.* Perform tests in a suitable chamber to reduce or eliminate the possibility of test fluctuation due to air movement. The chamber shall have a minimum floor area of 10 by 10 feet (305 by 305 cm).

(i) *Ventilation hood.* Provide the test chamber with an exhaust system capable of removing the products of combustion expelled during tests.

(c) Test Specimens.

(1) *Specimen preparation.* Prepare a minimum of three specimen sets of the same construction and configuration for testing.

(2) *Insulation blanket test specimen.*

(i) For batt-type materials such as fiberglass, the constructed, finished blanket specimen assemblies shall be 32 inches wide by 36 inches long (81.3 by 91.4 cm), exclusive of heat sealed film edges.

(ii) For rigid and other non-conforming types of insulation materials, the finished test specimens shall fit into the test rig in such a manner as to replicate the actual in-service installation.

(3) *Construction.* Make each of the specimens tested using the principal components (i.e., insulation, fire barrier material if used, and moisture barrier film) and assembly processes (representative seams and closures).

(i) *Fire barrier material.* If the insulation blanket is constructed with a fire barrier material, place the fire barrier material in a manner reflective of the installed arrangement For example, if the material will be placed on the outboard side of the insulation material, inside the moisture film, place it the same way in the test specimen.

(ii) *Insulation material.* Blankets that utilize more than one variety of insulation (composition, density, etc.) shall have specimen sets constructed that reflect the insulation combination used. If, however, several blanket types use similar insulation combinations, it is not necessary to test each combination if it is possible to bracket the various combinations.

(iii) *Moisture barrier film.* If a production blanket construction utilizes more than one type of moisture barrier film, perform separate tests on each combination. For example, if a polyimide film is used in conjunction with an insulation in order to enhance the burnthrough capabilities, also test the same insulation when used with a polyvinyl fluoride film.

(iv) *Installation on test frame.* Attach the blanket test specimens to the test frame using 12 steel spring type clamps as shown in figure 7. Use the clamps to hold the blankets in place in both of the outer vertical formers, as well as the centre vertical former (4 clamps per former). The clamp surfaces should measure 1 inch by 2 inches (25 by 51 mm). Place the top and bottom clamps 6 inches (15.2 cm) from the top and bottom of the test frame, respectively. Place the middle clamps 8 inches (20.3 cm) from the top and bottom clamps.

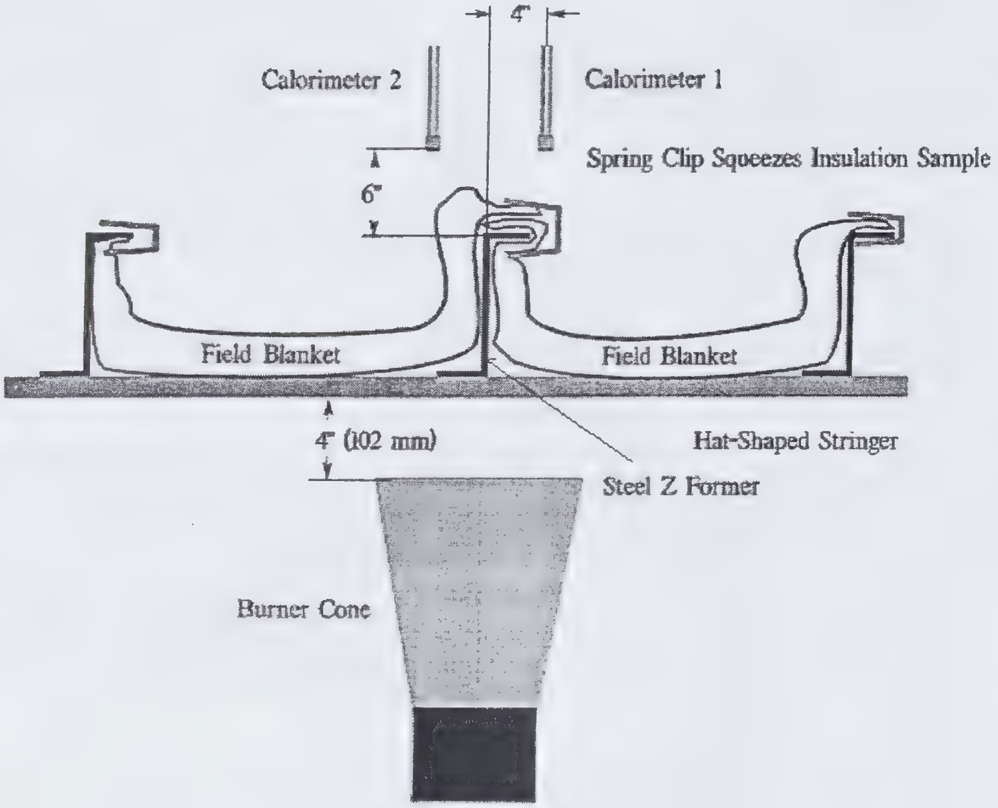


Figure 7 – Test Specimen Installation on Test Frame

(Note: For blanket materials that cannot be installed in accordance with figure 7 above, the blankets shall be installed in a manner approved by Transport Canada, Civil Aviation.)

(v) Conditioning. Condition the specimens at 70° +/-5° F (21° +/- 2° C) and 55% +/- 10% relative humidity for a minimum of 24 hours prior to testing.

(d) Preparation of apparatus.

(1) Level and centre the frame assembly to ensure alignment of the calorimeter and/or thermocouple rake with the burner cone.

(2) Turn on the ventilation hood for the test chamber. Do not turn on the burner blower. Measure the airflow of the test chamber using a vane anemometer or equivalent measuring device. The vertical air velocity just behind the top of the upper insulation blanket test specimen shall be 100 +/- 50 ft/min (0.51 +/- 0.25 m/s). The horizontal air velocity at this point shall be less than 50 ft/min (0.25 m/s).

(3) If a calibrated flow meter is not available, measure the fuel flow rate using a graduated cylinder of appropriate size. Turn on the burner motor/fuel pump, after insuring that the igniter system is turned off. Collect the fuel via a plastic or rubber tube into the graduated cylinder for a 2-minute period. Determine the flow rate in gallons per hour. The fuel flow rate shall be 6.0 +/- 0.2 gallons per hour (0.378 +/-0.0126 L/min).

(e) Calibration.

(1) Position the burner in front of the calorimeter so that it is centered and the vertical plane of the burner cone exit is 4 +/- 0.125 inches (102 +/- 3 mm) from the calorimeter face. Ensure that the horizontal centerline of the burner cone is offset 1 inch below the horizontal centerline of the calorimeter (figure 8). Without disturbing the calorimeter position, rotate the burner in front of the thermocouple rake, such that the middle thermocouple (number 4 of 7) is centered on the burner cone. Ensure that the horizontal centerline of the burner cone is also offset 1 inch below the horizontal centerline of the thermocouple tips. Re-check measurements by rotating the burner to each position to ensure proper alignment between the cone and the calorimeter and thermocouple rake.

Note*: The test burner mounting system shall incorporate "detents" that ensure proper centering of the burner cone with respect to both the calorimeter and the thermocouple rakes, so that rapid positioning of the burner can be achieved during the calibration procedure.*

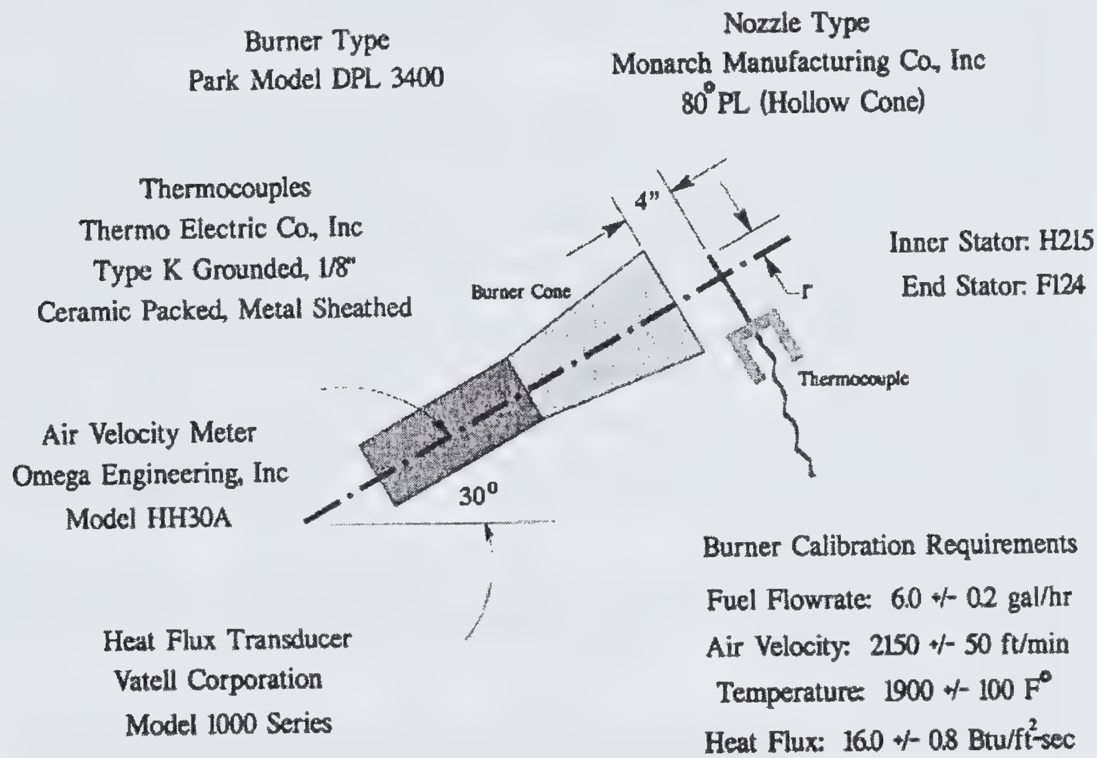


Figure 8 – Burner Information and Calibration Settings

(2) Position the air velocity meter in the adapter or airbox, making certain that no gaps exist where air could leak around the air velocity measuring device. Turn on the blower/motor while ensuring that the fuel solenoid and igniters are off. Adjust the air intake velocity to a level of 2150 ft/min, (10.92 m/s) then turn off the blower/motor.

Note: *The Omega HH30 air velocity meter measures 2.625 inches in diameter. To calculate the intake airflow, multiply the cross-sectional area (0.03758 ft^2) by the air velocity (2150 ft/min) to obtain 80.80 ft^3/min. An air velocity meter other than the HH30 unit can be used, provided the calculated airflow of 80.80 ft^3/min (2.29 m^3/ min) is equivalent.*

(3) Rotate the burner from the test position to the warm-up position. Prior to lighting the burner, ensure that the calorimeter face is clean of soot deposits, and there is water running through the calorimeter. Examine and clean the burner cone of any evidence of buildup of products of combustion, soot, etc. Soot buildup inside the burner cone may affect the flame characteristics and cause calibration difficulties. Since the burner cone may distort with time, dimensions should be checked periodically.

(4) While the burner is still rotated to the warm-up position, turn on the blower/motor, igniters and fuel flow, and light the burner. Allow it to warm up for a period of 2 minutes. Move the burner into the calibration position and allow 1 minute for calorimeter stabilization, then record the heat flux once every second for a period of 30 seconds. Turn off burner, rotate out of position, and allow to cool. Calculate the average heat flux over this 30-second duration. The average heat flux should be 16.0 +/- 0.8 BTU/ft^2 - second (18.2 +/- 0.9 W/cm^2).

(5) Position the burner in front of the thermocouple rake. After checking for proper alignment, rotate the burner to the warm-up position, turn on the blower/motor, igniters and fuel flow, and light the burner. Allow it to warm up for a period of 2 minutes. Move the burner into the calibration position and allow 1 minute for thermocouple stabilization, then record the temperature of each of the 7 thermocouples once every second for a period of 30 seconds. Turn off burner, rotate out of position, and allow to cool. Calculate the average temperature of each thermocouple over this 30-second period and record. The average temperature of each of the 7 thermocouples should be 1900 +/- 100° F (1038 +/- 56° C).

(6) If either the heat flux or the temperatures are not within the specified range, adjust the burner intake air velocity and repeat the procedures of paragraphs (4) and (5) above to obtain the proper values. Ensure that the inlet air velocity is within the range of 2150 +/- 50 ft/min (10.92 +/- 0.25 m/s).

(7) Calibrate prior to each test until consistency has been demonstrated. After consistency has been confirmed, several tests may be conducted with calibration conducted before and after a series of tests.

(f) Test procedure.

(1) Secure the two insulation blanket test specimens to the test frame. The insulation blankets should be attached to the test rig centre vertical former using four spring clamps positioned as shown in figure 7 (according to the criteria of (c)(3)(iv) of this part of this appendix).
(amended 2012/03/27)

(2) Ensure that the vertical plane of the burner cone is at a distance of 4 +/- 0.125 inch (102 +/- 3 mm) from the outer surface of the horizontal stringers of the test specimen frame, and that the burner and test frame are both situated at a 30° angle with respect to vertical.

(3) When ready to begin the test, direct the burner away from the test position to the warm-up position so that the flame will not impinge on the specimens prematurely. Turn on and light the burner and allow it to stabilize for 2 minutes.

(4) To begin the test, rotate the burner into the test position and simultaneously start the timing device.

(5) Expose the test specimens to the burner flame for 4 minutes and then turn off the burner. Immediately rotate the burner out of the test position.

(6) Determine (where applicable) the burnthrough time, or the point at which the heat flux exceeds 2.0 BTU/ft^2 - second (2.27 W/cm^2).

(g) Report.

(1) Identify and describe the specimen being tested.

(2) Report the number of insulation blanket specimens tested.

(3) Report the burnthrough time (if any), and the maximum heat flux on the back face of the insulation blanket test specimen, and the time at which the maximum occurred.

(h) Requirements.

(1) Each of the two insulation blanket test specimens shall not allow fire or flame penetration in less than 4 minutes.

(2) Each of the two insulation blanket test specimens shall not allow more than 2.0 Btu/ft^2 - sec (2.27 W/cm^2) on the cold side of the insulation specimens at a point 12 inches (30.5 cm) from the face of the test rig.

APPENDIX G

Continuous Gust Design Criteria

The continuous gust design criteria in this appendix must be used in establishing the dynamic response of the aeroplane to vertical and lateral continuous turbulences unless a more rational criteria is used. The following gust load requirements apply to mission analysis and design envelope analysis.

(a) The limit gust loads utilising the continuous turbulence concept must be determined in accordance with the provisions of either paragraph *(b)* or paragraphs *(c)* and *(d)* of this Appendix.

(b) Design envelope analysis. The limit loads must be determined in accordance with the following:

(1) All critical altitudes, weights, and weight distributions, as specified in 525.321(b), and all critical speeds within the ranges indicated in paragraph (b)(3) of this appendix must be considered.

(2) Values of $\bar{A}$ (ratio of root-mean-square incremental load root-mean-square gust velocity) must be determined by dynamic analysis. The power spectral density of the atmospheric turbulence must be as given by the equation:

$$\phi(\Omega) = \frac{\delta^2 L}{\eta} \frac{1 + \frac{8}{3}(1.339\, L\Omega)^2}{[1 + (1.339\, L\Omega)^2]^{11/6}}$$

where:

Φ = power-spectral density $(\text{ft/sec})^2$ rad./ft.

σ = root-mean-square gust velocity, ft/sec.

Ω = reduced frequency, radians per foot.

L = 2,500 ft.

(3) The limit loads must be obtained by multiplying the $\bar{A}$ values determined by the dynamic analysis by the following values of the gust velocity $U\sigma$:

(i) At speed V_c: $U\sigma$ = 85 fps true gust velocity in the interval 0 to 30,000 ft. altitude and is linearly decreased to 30 fps true gust velocity at 80,000 ft. altitude. Where the Minister finds that a design is comparable to a similar design with extensive satisfactory service experience, it will be acceptable to select Us at V_c less than 85 fps, but not less than 75 fps, with linear decrease from that value at 20,000 feet to 30 fps at 80,000 feet. The following factors will be taken into account when assessing comparability to a similar design:

(A) The transfer function of the new design should exhibit no unusual characteristics as compared to the similar design which will significantly affect response to turbulence; e.g, coalescence of modal response in the frequency regime which can result in a significant increase of loads.

(B) The typical mission of the new aeroplane is substantially equivalent to that of the similar design.

(C) The similar design should demonstrate the adequacy of the $U\sigma$ selected.

(ii) At speed V_B: $U\sigma$ is equal to 1.32 times the values obtained under paragraph (b)(3)(i) of this Appendix.

(iii) At speed V_D: $U\sigma$ is equal to 1/2 the values obtained under paragraph (b)(3)(i) of this Appendix.

(iv) At speeds between V_B and V_C and between V_C and V_D: $U\sigma$ is equal to a value obtained by linear interpolation.

(4) When a stability augmentation system is included in the analysis, the effect of system nonlinearities on loads at the limit load level must be realistically or conservatively accounted for.

(c) Mission analysis. Limit loads must be determined in accordance with the following:

(1) The expected utilisation of the aeroplane must be represented by one or more flight profiles in which the load distribution and the variation with time of speed, altitude, gross weight, and centre of gravity position are defined. These profiles must be divided into mission segments or blocks, for analysis, and average or effective values of the pertinent parameters defined for each segment.

(2) For each of the mission segments defined under paragraph (c) (1) of this Appendix, values of $\bar{A}$ and N_o must be determined by analysis. $\bar{A}$ is defined as the ratio of root-mean-square incremental load to root-mean-square gust velocity and N_o is the radius of gyration of the load power spectral density function about zero frequency. The power spectral density of the atmospheric turbulence must be given by the equation set forth in paragraph (b)(2) of this Appendix.

(3) For each of the load and stress quantities selected, the frequency of exceedance must be determined as a function of load level by means of the equation:

$$N_{(\gamma)} = \sum t N_0 \left[P_1 \exp\left(-\frac{|y - y_{one-g}|}{b_1 \bar{A}} \right) + P_2 \exp\left(-\frac{|y - y_{one-g}|}{b_2 \bar{A}} \right) \right]$$

where

t = selected time interval.

y = net value of the load or stress.

y_{one-g} = value of the load or stress in one-g level flight.

$N_{(\gamma)}$ = average number of exceedances of the indicated value of the load or stress in unit time.

Σ = symbol denoting summation over all mission segments.

N_o, $\bar{A}$ = parameters determined by dynamic analysis as defined in paragraph (c)(2) of this Appendix.

P_1,P_2,b_1,b_2, = parameters defining the probability distributions of root-mean-square gust velocity, to be read from Figures 1 and 2 of this Appendix.

The limit gust loads must be read from the frequency of exceedance curves at a frequency of exceedance of 2 x 10^{-5} exceedances per hour. Both positive and negative load directions must be considered in determining the limit loads.

(4) If a stability augmentation system is utilised to reduce the gust loads, consideration must be given to the fraction of flight time that the system may be inoperative. The flight profiles of paragraph (c)(1) of this Appendix must include flight with the system inoperative for this fraction of the flight time. When a stability augmentation system is included in the analysis, the effect of system nonlinearities on loads at the limit load level must be conservatively accounted for.

(d) Supplementary design envelope analysis. In addition to the limit loads defined by paragraph *(c)* of this Appendix, limit loads must also be determined in accordance with paragraph *(b)* of this Appendix, except that:

(1) In paragraph (b)(3)(i) of this appendix, the value of $U\sigma$ = 85 fps true gust velocity is replaced by $U\sigma$ = 60 fps true gust velocity on the interval 0 to 30,000 ft. altitude, and is linearly decreased to 25 fps true gust velocity at 80,000 ft. altitude; and

(2) In paragraph (b) of this appendix, the reference to paragraphs (b)(3)(i) through (b)(3)(iii) of this Appendix is to be understood as referring to the paragraph as modified by paragraph (d)(1).

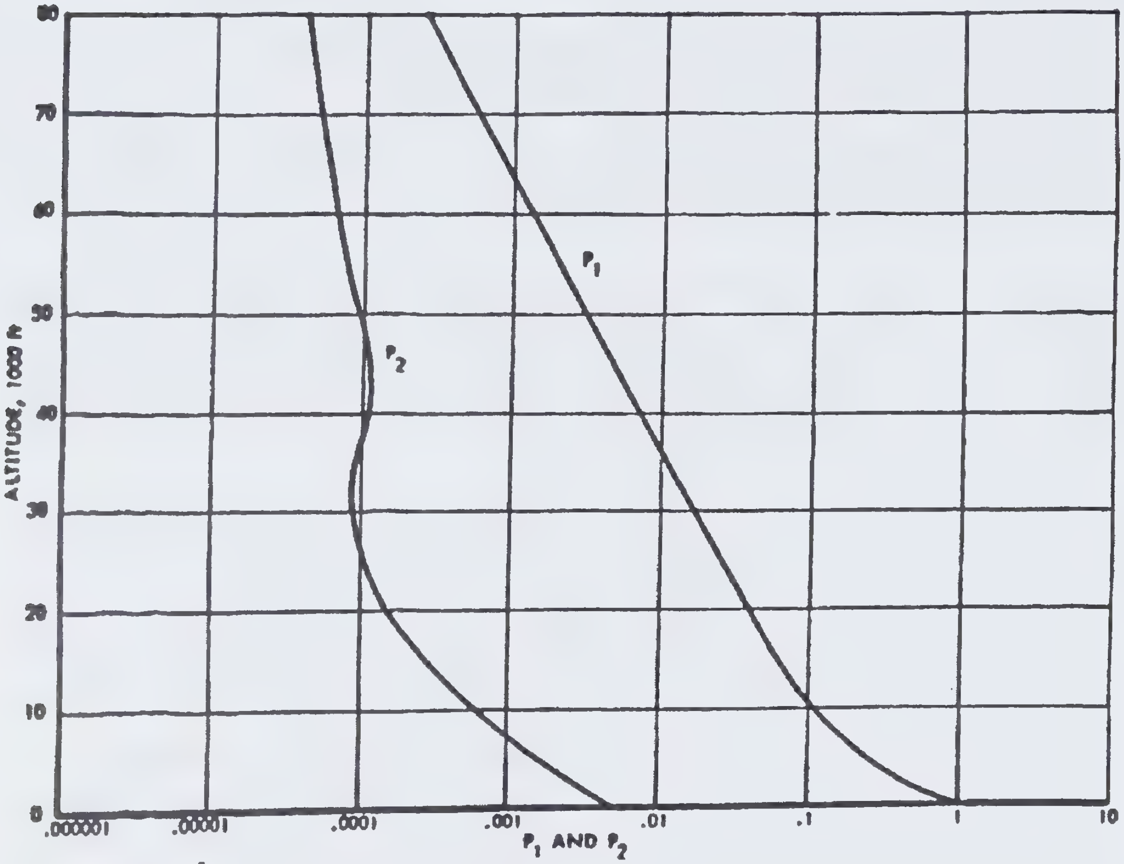


FIGURE 1 P_1 AND P_2 VALUES

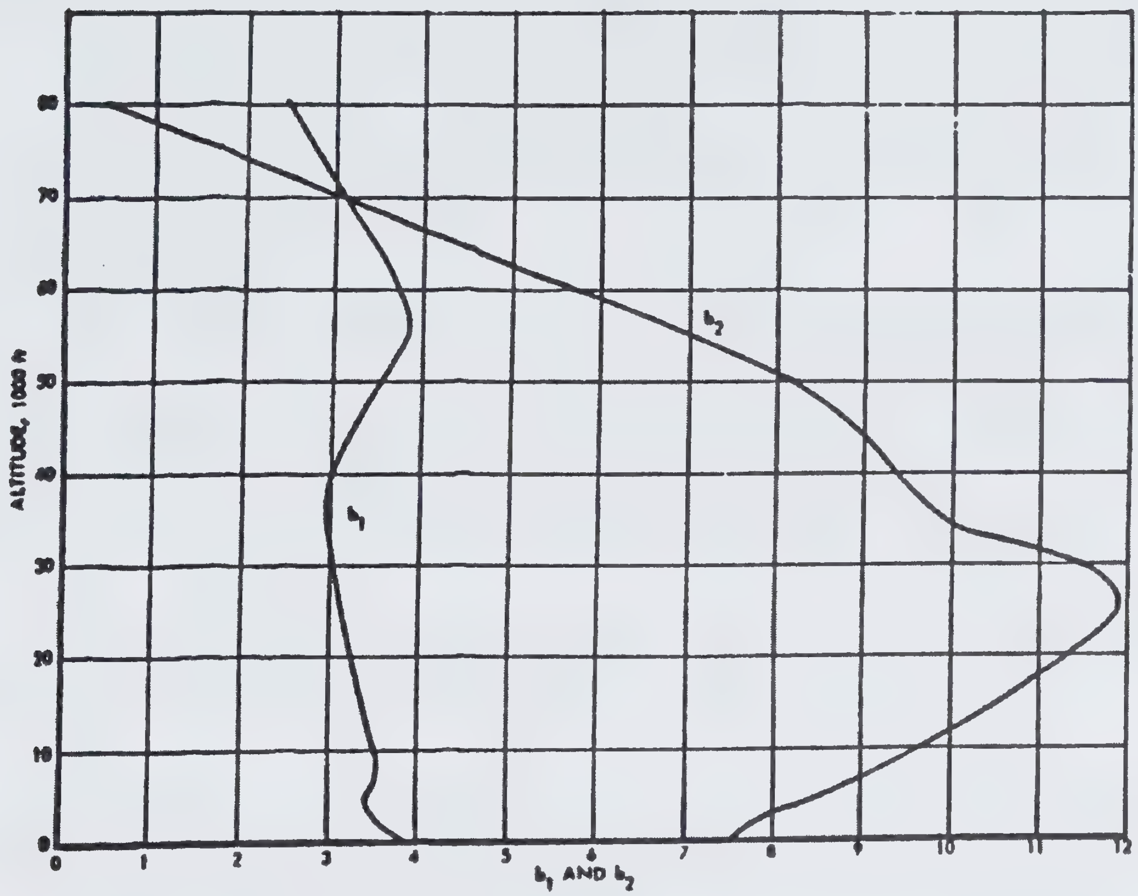


FIGURE 2 **b_1 AND b_2 VALUES**

APPENDIX H

Instructions For Continued Airworthiness

H525.1 *General*

(a) This appendix specifies requirements for preparation of Instructions for Continued Airworthiness as required by 525.1529, 525.1729 and applicable provisions of Part V of the *Canadian Aviation Regulations* (CARs).
(amended 2009/05/11)

(b) The Instructions for Continued Airworthiness for each aeroplane must include the Instructions for Continued Airworthiness for each engine and propeller (hereinafter designated "products"), for each appliance required by any applicable airworthiness or operating rule, and any required information relating to the interface of those appliances and products with the aeroplane. If Instructions for Continued Airworthiness are not supplied by the manufacturer of an appliance or product installed in the aeroplane, the Instructions for Continued Airworthiness for the aeroplane must include the information essential to the continued airworthiness of the aeroplane.

(c) The applicant must submit to the Minister a programme to show how changes to the Instructions for Continued Airworthiness made by the applicant or by the manufacturers of products and appliances installed in the aeroplane will be distributed.

H525.2 *Format*

(a) The Instructions for Continued Airworthiness must be in the form of a manual or manuals as appropriate for the quantity of data to be provided.

(b) The format of the manual or manuals must provide for a practical arrangement.

H525.3 *Content*

The Instructions for Continued Airworthiness must contain the following manuals or sections, as appropriate, and information:

(a) Aeroplane maintenance manual or section.

(1) Introduction information that includes an explanation of the aeroplane's features and data to the extent necessary for maintenance or preventive maintenance.

(2) A description of the aeroplane and its systems and installations including its engines, propellers, and appliances.

(3) Basic control and operation information describing how the aeroplane components and systems are controlled and how they operate, including any special procedures and limitations that apply.

(4) Servicing information that covers details regarding servicing points, capacities of tanks, reservoirs, types of fluids to be used, pressures applicable to the various systems, location of access panels for inspection and servicing, locations of lubrication points, lubricants to be used, equipment required for servicing, tow instructions and limitations, mooring, jacking, and levelling information.

(b) Maintenance Instructions.

(1) Scheduling information for each part of the aeroplane and its engines, auxiliary power units, propellers, accessories, instruments, and equipment that provides the recommended periods at which they should be cleaned, inspected, adjusted, tested, and lubricated, and the degree of inspection, the applicable wear tolerances, and work recommended at these periods. However, the applicant may refer to an accessory, instrument, or equipment manufacturer as the source of this information if the applicant shows that the item has an exceptionally high degree of complexity requiring specialised maintenance techniques, test equipment, or expertise. The recommended overhaul periods and necessary cross references to the Airworthiness Limitations section of the manual must also be included. In addition, the applicant must include an inspection program that includes the frequency and extent of the inspections necessary to provide for the continued airworthiness of the aeroplane.

(2) Troubleshooting information describing probable malfunctions, how to recognise those malfunctions, and the remedial action for those malfunctions.

(3) Information describing the order and method of removing and replacing products and parts with any necessary precautions to be taken.

(4) Other general procedural instructions including procedures for system testing during ground running, symmetry checks, weighing and determining the centre of gravity, lifting and shoring, and storage limitations.

(c) Diagrams of structural access plates and information needed to gain access for inspections when access plates are not provided.

(d) Details for the application of special inspection techniques including radiographic and ultrasonic testing where such processes are specified.

(e) Information needed to apply protective treatments to the structure after inspection.

(f) All data relative to structural fasteners such as identification, discard recommendations, and torque values.

(g) A list of special tools needed.

H525.4 *Airworthiness Limitations Section*

(a) The Instructions for Continued Airworthiness must contain a section titled Airworthiness Limitations that is segregated and clearly distinguishable from the rest of the document. This section must set forth:
(amended 2009/05/11)

(1) Each mandatory modification time, replacement time, structural inspection interval, and related structural inspection procedure approved under 525.571;
(amended 2012/03/27)

(2) Each mandatory replacement time, inspection interval, related inspection procedure, and all critical design configuration control limitations approved under 525.981 for the fuel tank system; and

(3) Any mandatory replacement time of EWIS components as defined in section 525.1701.
(amended 2009/05/11)

(4) A limit of validity (LOV) of the engineering data that supports the structural maintenance program, stated as a total number of accumulated flight cycles or flight hours or both, approved under 525.571. Until the full-scale fatigue testing is completed and the Minister has approved the LOV, the number of cycles accumulated by the aeroplane cannot be greater than ½ the number of cycles accumulated on the fatigue test article.
(amended 2012/03/27)

(b) If the Instructions for Continued Airworthiness consist of multiple documents, the section required by H525.4*(a)* above shall be included in the principal manual. This section must contain a legible statement in a prominent location that reads: "The Airworthiness Limitations section is approved by the Minister and specifies maintenance required by any applicable airworthiness or operating rule, unless an alternative program has been approved by the Minister."
(amended 2002/08/19)

H525.5 *Electrical Wiring Interconnection System (EWIS) Instructions for Continued Airworthiness*

(amended 2009/05/11)

(a) The applicant must prepare Instructions for Continued Airworthiness (ICA) applicable to EWIS as defined by 525.1701 that are approved by the Minister and include the following:
(amended 2009/05/11)

(1) Maintenance and inspection requirements for the EWIS developed with the use of an enhanced zonal analysis procedure that includes:
(amended 2009/05/11)

(i) Identification of each zone of the aeroplane.
(amended 2009/05/11)

(ii) Identification of each zone that contains EWIS.
(amended 2009/05/11)

(iii) Identification of each zone containing EWIS that also contains combustible materials.
(amended 2009/05/11)

(iv) Identification of each zone in which EWIS is in close proximity to both primary and back-up hydraulic, mechanical or electrical flight controls and lines.
(amended 2009/05/11)

(v) Identification of:
(amended 2009/05/11)

(A) Tasks, and the intervals for performing those tasks, that will reduce the likelihood of ignition sources and accumulation of combustible material, and
(amended 2009/05/11)

(B) Procedures, and the intervals for performing those procedures, that will effectively clean the EWIS components of combustible material if there is not an effective task to reduce the likelihood of combustible material accumulation.
(amended 2009/05/11)

(vi) Instructions for protection and caution information that will minimize contamination and accidental damage to EWIS, as applicable, during performance of maintenance, alteration or repairs.
(amended 2009/05/11)

(2) Acceptable EWIS maintenance practices in a standard format.
(amended 2009/05/11)

(3) Wire separation requirements as determined under 525.1707.
(amended 2009/05/11)

(4) Information explaining the EWIS identification method and requirements for identifying any changes to EWIS under 525.1711.
(amended 2009/05/11)

(5) Electrical load data and instructions for updating that data.
(amended 2009/05/11)

(b) The EWIS ICA developed in accordance with the requirements of H525.5(a)(1) must be in the form of a document appropriate for the information to be provided, and they must be easily recognizable as EWIS ICA. This document must either contain the required EWIS ICA or specifically reference other portions of the ICA that contain this information.
(amended 2009/05/11)

(Change 525-2 (89-01-01))

(Change 525-3 (91-11-01))

APPENDIX I

Installation of an Automatic Take-off Thrust Control System (ATTCS)

I525.1 *General*

(a) This appendix specifies additional requirements for installation of engine power control system that automatically resets thrust or power on operating engine(s) in the event of any one engine failure during take-off.

(b) With the ATTCS and associated systems functioning normally as designed, all applicable requirements of Chapter 525, except as provided in this appendix, must be met without requiring any action by the crew to increase thrust or power.

I525.2 *Definitions*

(a) Automatic Take-off Thrust Control System (ATTCS). An ATTCS is defined as the entire automatic system used on take-off, including all devices, both mechanical and electrical, that sense engine failure, transmit signals, actuate fuel controls or power levers or increase engine power by other means on operating engines to achieve scheduled thrust or power increases, and furnish cockpit information on system operation.

(b) Critical Time Interval. When conducting an ATTCS take-off, the critical time interval is between V_1 minus 1 second and a point on the minimum performance, all-engine flight path where, assuming a simultaneous occurrence of an engine and ATTCS failure, the resulting minimum flight path there after intersects the Chapter 525 required actual flight path at no less than 400 feet above the take-off surface. This time interval is shown in the following illustration:

I525.3 *Performance and System Reliability Requirements*

The applicant must comply with the performance and ATTCS reliability requirements as follows:

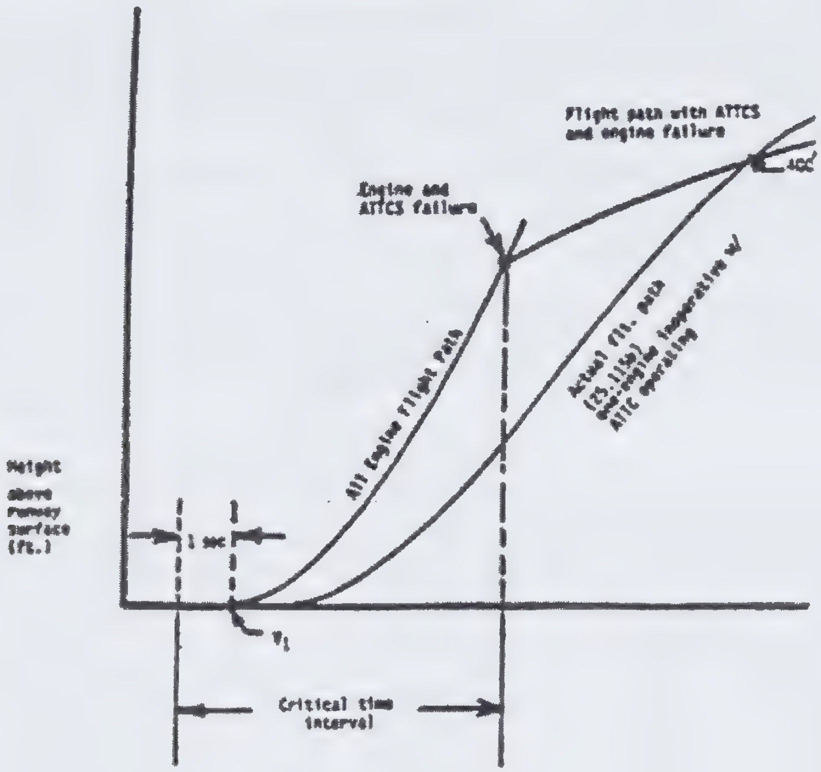
(a) An ATTCS failure or a combination of failures in the ATTCS during the critical time interval:

(1) Shall not prevent the insertion the *maximum approved take-off* thrust or power, or must be shown to be an improbable event.

(2) Shall not result in a significant loss or reduction in thrust or power, or must be shown to be an extremely improbable event.

(b) The concurrent existence of an ATTCS failure and an engine failure during the critical time interval must be shown to be extremely improbable.

(c) All applicable performance requirements of Chapter 525 must be met with an engine failure occurring at the most critical point during take-off with the ATTCS system functioning.



I525.4 *Thrust Setting*

The initial take-off thrust or power setting on each engine at the beginning of the take-off roll may not be less than any of the following:

(a) Ninety (90) percent of the thrust or power set by the ATTCS (the maximum take-off thrust or power approved for the aeroplane under existing ambient conditions);

(b) That required to permit normal operation of all safety-related systems and equipment dependent upon engine thrust or power lever position; or

(c) That shown to be free of hazardous engine response characteristics when thrust or power is advanced from the initial take-off thrust or power to the maximum approved take-off thrust or power.

I525.5 *Powerplant Controls*

(a) In addition to the requirements of 525.1141, no single failure or malfunction, or probable combination thereof, of the ATTCS, including associated systems, may cause the failure of any powerplant function necessary for safety.

(b) The ATTCS must be designed to:

(1) Apply thrust or power on the operating engine(s), following any one engine failure during take-off, to achieve the maximum approved take-off thrust or power without exceeding engine operating limits;

(2) Permit manual decrease or increase in thrust or power up to the maximum take-off thrust or power approved for the aeroplane under existing conditions through the use of the

power lever. For aeroplanes equipped with limiters that automatically prevent engine operating limits from being exceeded under existing ambient conditions, other means may be used to increase the thrust or power in the event of an ATTCS failure provided the means is located on or forward of the power levers; is easily identified and operated under all operating conditions by a single action of either pilot with the hand that is normally used to actuate the power levers; and meets the requirements of 525.777(a), (b) and (c);

(3) Provide a means to verify to the flight crew before take-off that the ATTCS is in a condition to operate; and

(4) Provide a means for the flight crew to deactivate the automatic function. This means must be designed to prevent inadvertent deactivation.

I525.6 *Powerplant Instruments*

In addition to the requirements of 525.1305:

(a) A means must be provided to indicate when the ATTCS is in the armed or ready condition; and

(b) If the inherent flight characteristics of the aeroplane do not provide adequate warning that an engine has failed, a warning system that is independent of the ATTCS must be provided to give the pilot a clear warning of any engine failure during take-off.

(Change 525-2 (89-01-01))

APPENDIX J

Emergency Evacuation

The following test criteria and procedures must be used for showing compliance with 525.803:

(a) The emergency evacuation shall be conducted with exterior ambient light levels of no greater than 0.3 foot-candles prior to the activation of the aeroplane emergency lighting system. The source(s) of the initial exterior ambient light level may remain active or illuminated during the actual demonstration. There shall, however, be no increase in the exterior ambient light level except for that due to activation of the aeroplane emergency lighting system.
(amended 2007/03/08)

(b) The aeroplane must be in a normal attitude with landing gear extended.

(c) Unless the aeroplane is equipped with an off-wing descent means, stands or ramps may be used for descent from the wing to the ground. Safety equipment such as mats or inverted life rafts may be placed on the floor or ground to protect participants. No other equipment that is not part of the emergency evacuation equipment of the aeroplane may be used to aid the participants in reaching the ground.

(d) Except as provided in paragraph *(a)* of this Appendix, only the aeroplane's emergency lighting system may provide illumination.

(e) All emergency equipment required for the planned operation of the aeroplane must be installed.

(f) Each internal door or curtain shall be in the take-off configuration.
(amended 2007/03/08)

(g) Each crew member shall be seated in the normally assigned seat for take-off and shall remain in the seat until receiving the signal for commencement of the demonstration. Each crew member shall be a person having knowledge of the operation of exits and emergency equipment and, if compliance with section 705.104 is also being demonstrated, each flight attendant must be a member of a regularly scheduled line crew.
(amended 2007/03/08)

(h) a representative passenger load of persons in normal health must be used as follows:

(1) At least 40 percent of the passenger load must be female.

(2) At least 35 percent of the passenger load must be over 50 years of age.

(3) At least 15 percent of the passenger load must be female and over 50 years of age.

(4) Three life-size dolls, not included as part of the total passenger load, must be carried by passengers to simulate live infants 2 years old or younger.

(5) Crew members, mechanics, and training personnel, who maintain or operated the aeroplane in the normal course of their duties, may not be used as passengers.

(i) No passenger may be assigned a specific seat except as the Minister may require. Except as required by subparagraph *(g)* of this paragraph, no employee of the applicant may be seated next to an emergency exit.

(j) Seat belts and shoulder harnesses (as required) must be fastened.

(k) Before the start of the demonstration, approximately one-half of the total average amount of carry-on baggage, blankets, pillows, and other similar articles must be distributed at several locations in aisles and emergency exit access ways to create minor obstructions.

(l) No prior indication may be given to any crewmember or passenger of the particular exits to be used in the demonstration.

(m) The applicant may not practice, rehearse, or describe the demonstration within the preceding 6 months.

(n) Prior to entering the demonstration aeroplane, the passengers may also be advised to follow directions of crew members but not be instructed on the procedures to be followed in the demonstration, except with respect to safety procedures in place for the demonstration or which have to do with the demonstration site. Prior to the start of the demonstration, the pre-take-off passenger briefing required by section 705.43 may be given. Flight attendants may assign demonstration subjects to assist persons from the bottom of a slide, consistent with their approved training program.
(amended 2007/03/08)

(o) The aeroplane shall be configured to prevent disclosure of the active emergency exits to demonstration participants in the aeroplane until the start of the demonstration.
(amended 2007/03/08)

(p) Exits used in the demonstration shall consist of one exit from each exit pair. The demonstration may be conducted with the escape slides, if provided, inflated and the exits open at the beginning of the demonstration. In this case, all exits shall be configured such that the active exits are not disclosed to the occupants. If this method is used, the exit preparation time for each exit utilized shall be accounted for, and exits that are not to be used in the demonstration shall not be indicated before the demonstration has started. The exits to be used shall be representative of all the emergency exits on the aeroplane and shall be designated by the applicant, subject to approval by the Minister. At least one floor level exit shall be used.
(amended 2007/03/08)

(q) Except as provided in paragraph *(c)* of this section, all evacuees must leave the aeroplane by a means provided as part of the aeroplane's equipment.

(r) The applicant's approved procedures must be fully utilised, except the flight crew must take no active role in assisting others inside the cabin during the demonstration.

(s) The evacuation time period is completed when the last occupant has evacuated the aeroplane and is on the ground. Provided that the acceptance rate of the stand or ramp is no greater than the acceptance rate of the means available on the aeroplane for descent from the wing during an actual crash situation, evacuees using stands or ramps allowed by paragraph *(c)* of this Appendix are considered to be on the ground when they are on the stand or ramp.

(Change 525-3 (91-11-01))
(Change 525-6 (93-12-30))

APPENDIX L
(amended 2008/10/30)

HIRF Environments and Equipment HIRF Test Levels
(amended 2008/10/30)

This appendix specifies the HIRF environments and equipment HIRF test levels for electrical and electronic systems under 525.1317. The field strength values for the HIRF environments and equipment HIRF test levels are expressed in root-mean-square units measured during the peak of the modulation cycle.
(amended 2008/10/30)

(a) HIRF environment I is specified in the following table:
(amended 2008/10/30)

Table I — HIRF Environment I

Frequency	Field Strength (volts/meter)	
	Peak	Average
10 kHz – 2 MHz	50	50
2 MHz – 30 MHz	100	100
30 MHz – 100 MHz	50	50
100 MHz – 400 MHz	100	100
400 MHz – 700 MHz	700	50
700 MHz – 1 GHz	700	100
1 GHz – 2 GHz	2000	200
2 GHz – 6 GHz	3000	200
6 GHz – 8 GHz	1000	200
8 GHz – 12 GHz	3000	300
12 GHz – 18 GHz	2000	200
18 GHz – 40 GHz	600	200
In this table, the higher field strength applies at the frequency band edges		
(amended 2008/10/30)		

(b) HIRF environment II is specified in the following table:
(amended 2008/10/30)

Table II — HIRF Environment II

Frequency	Field Strength (volts/meter)	
	Peak	Average
10 kHz – 500 kHz	20	20

Frequency	Field Strength (volts/meter)	
	Peak	Average
500 kHz – 2 MHz	30	30
2 MHz – 30 MHz	100	100
30 MHz – 100 MHz	10	10
100 MHz – 200 MHz	30	10
200 MHz – 400 MHz	10	10
400 MHz – 1 GHz	700	40
1 GHz – 2 GHz	1300	160
2 GHz – 4 GHz	3000	120
4 GHz – 6 GHz	3000	160
6 GHz – 8 GHz	400	170
8 GHz – 12 GHz	1230	230
12 GHz – 18 GHz	730	190
18 GHz – 40 GHz	600	150
In this table, the higher field strength applies at the frequency band edges		
(amended 2008/10/30)		

(c) Equipment HIRF Test Level 1
(amended 2008/10/30)

(1) From 10 kilohertz (kHz) to 400 megahertz (MHz), use conducted susceptibility tests with continuous wave (CW) and 1 kHz square wave modulation with 90 percent depth or greater. The conducted susceptibility current shall start at a minimum of 0.6 milliamperes (mA) at 10 kHz, increasing 20 decibels (dB) per frequency decade to a minimum of 30 mA at 500 kHz.
(amended 2008/10/30)

(2) From 500 kHz to 40 MHz, the conducted susceptibility current shall be at least 30 mA.
(amended 2008/10/30)

(3) From 40 MHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 30 mA at 40 MHz, decreasing 20 dB per frequency decade to a minimum of 3 mA at 400 MHz.
(amended 2008/10/30)

(4) From 100 MHz to 400 MHz, use radiated susceptibility tests at a minimum of 20 volts per meter (V/m) peak with CW and 1 kHz square wave modulation with 90 percent depth or greater.
(amended 2008/10/30)

(5) From 400 MHz to 8 gigahertz (GHz), use radiated susceptibility tests at a minimum of 150 V/m peak with pulse modulation of 4 percent duty cycle with a 1 kHz pulse repetition frequency. This signal shall be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent.
(amended 2008/10/30)

(d) Equipment HIRF Test Level 2
(amended 2008/10/30)

Equipment HIRF test level 2 is HIRF environment II in table II of this appendix reduced by acceptable aircraft transfer function and attenuation curves. Testing shall cover the frequency band of 10 kHz to 8 GHz.
(amended 2008/10/30)

(e) Equipment HIRF Test Level 3
(amended 2008/10/30)

(1) From 10 kHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 0.15 mA at 10 kHz, increasing 20 dB per frequency decade to a minimum of 7.5 mA at 500 kHz.
(amended 2008/10/30)

(2) From 500 kHz to 40 MHz, use conducted susceptibility tests at a minimum of 7.5 mA.
(amended 2008/10/30)

(3) From 40 MHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 7.5 mA at 40 MHz, decreasing 20 dB per frequency decade to a minimum of 0.75 mA at 400 MHz.
(amended 2008/10/30)

(4) From 100 MHz to 8 GHz, use radiated susceptibility tests at a minimum of 5 V/m.
(amended 2008/10/30)

APPENDIX M
(amended 2009/05/11)

Fuel Tank System Flammability Reduction Means
(amended 2009/05/11)

M525.1 Fuel Tank Flammability Exposure Requirements
(amended 2009/05/11)

(a) The Fleet Average Flammability Exposure of each fuel tank, as determined in accordance with Appendix N of this chapter, may not exceed 3 percent of the Flammability Exposure Evaluation Time (FEET), as defined in Appendix N of this chapter. As a portion of this 3 percent, if flammability reduction means (FRM) are used, each of the following time periods may not exceed 1.8 percent of the FEET:
(amended 2009/05/11)

(1) When any FRM is operational but the fuel tank is not inert and the tank is flammable; and
(amended 2009/05/11)

(2) When any FRM is inoperative and the tank is flammable.
(amended 2009/05/11)

(b) The Fleet Average Flammability Exposure, as defined in Appendix N of this chapter, of each fuel tank may not exceed 3 percent of the portion of the FEET occurring during either ground or takeoff/climb phases of flight during warm days. The analysis must consider the following conditions.
(amended 2009/05/11)

(1) The analysis must use the subset of those flights that begin with a sea level ground ambient temperature of 80° F (standard day plus 21° F atmosphere) or above, from the flammability exposure analysis done for overall performance.
(amended 2009/05/11)

(2) For the ground and takeoff/climb phases of flight, the average flammability exposure must be calculated by dividing the time during the specific flight phase the fuel tank is flammable by the total time of the specific flight phase.
(amended 2009/05/11)

(3) Compliance with this paragraph may be shown using only those flights for which the aeroplane is dispatched with the flammability reduction means operational.
(amended 2009/05/11)

M525.2 Showing Compliance
(amended 2009/05/11)

(a) The applicant must provide data from analysis, ground testing and flight testing, or any combination of these, that:
(amended 2009/05/11)

(1) Validate the parameters used in the analysis required by M525.1 of this appendix;
(amended 2009/05/11)

(2) Substantiate that the FRM is effective at limiting flammability exposure in all compartments of each tank for which the FRM is used to show compliance with M525.1 of this appendix; and
(amended 2009/05/11)

(3) Describe the circumstances under which the FRM would not be operated during each phase of flight.
(amended 2009/05/11)

(b) The applicant must validate that the FRM meets the requirements of M525.1 of this appendix with any aeroplane or engine configuration affecting the performance of the FRM for which approval is sought.
(amended 2009/05/11)

M525.3 Reliability Indications and Maintenance Access
(amended 2009/05/11)

(a) Reliability indications must be provided to identify failures of the FRM that would otherwise be latent and whose identification is necessary to ensure the fuel tank with an FRM meets the fleet average flammability exposure requirements listed in M525.1 of this appendix, including when the FRM is inoperative.
(amended 2009/05/11)

(b) Sufficient accessibility to FRM reliability indications must be provided for maintenance personnel or the flight crew.
(amended 2009/05/11)

(c) The access doors and panels to the fuel tanks with FRMs (including any tanks that communicate with a tank via a vent system), and to any other confined spaces or enclosed areas that could contain hazardous atmosphere under normal conditions or failure conditions, must be permanently stencilled, marked, or placarded to warn maintenance personnel of the possible presence of a potentially hazardous atmosphere.
(amended 2009/05/11)

M525.4 Airworthiness Limitations and Procedures
(amended 2009/05/11)

(a) If FRM is used to comply with M525.1 of this appendix, Airworthiness Limitations must be identified for all maintenance or inspection tasks required to identify failures of components within the FRM that are needed to meet M525.1 of this appendix.
(amended 2009/05/11)

(b) Maintenance procedures must be developed to identify any hazards to be considered during maintenance of the FRM. These procedures must be included in the instructions for continued airworthiness (ICA).
(amended 2009/05/11)

M525.5 Reliability Reporting
(amended 2009/05/11)

The effects of aeroplane component failures on FRM reliability must be assessed on an on-going basis. The applicant/holder must do the following:
(amended 2009/05/11)

(a) Demonstrate effective means to ensure collection of FRM reliability data. The means must provide data affecting FRM reliability, such as component failures. (amended 2009/05/11)

(b) Unless alternative reporting procedures are approved by the Minister, provide a report to Transport Canada every six months for the first five years after service introduction. After that period, continued reporting every six months may be replaced with other reliability tracking methods found acceptable to the Minister or eliminated if it is established that the reliability of the FRM meets, and will continue to meet, the exposure requirements of M525.1 of this appendix.
(amended 2009/05/11)

(c) Develop service instructions or revise the applicable aeroplane manual, according to a schedule approved by the Minister, to correct any failures of the FRM that occur in service that could increase any fuel tank's Fleet Average Flammability Exposure to more than that required by M525.1 of this appendix.
(amended 2009/05/11)

APPENDIX N
(amended 2009/05/11)

Fuel Tank Flammability Exposure and Reliability Analysis
(amended 2009/05/11)

N525.1 General
(amended 2009/05/11)

(a) This appendix specifies the requirements for conducting fuel tank fleet average flammability exposure analyses required to meet 525.981(b) and Appendix M of this chapter. For fuel tanks installed in aluminum wings, a qualitative assessment is sufficient if it substantiates that the tank is a conventional unheated wing tank.
(amended 2009/05/11)

(b) This appendix defines parameters affecting fuel tank flammability that must be used in performing the analysis. These include parameters that affect all aeroplanes within the fleet, such as a statistical distribution of ambient temperature, fuel flash point, flight lengths and aeroplane descent rate. Demonstration of compliance also requires application of factors specific to the aeroplane model being evaluated. Factors that need to be included are maximum range, cruise mach number, typical altitude where the aeroplane begins initial cruise phase of flight, fuel temperature during both ground and flight times and the performance of a flammability reduction means (FRM) if installed.
(amended 2009/05/11)

(c) The following definitions, input variables, and data tables must be used in the program to determine fleet average flammability exposure for a specific aeroplane model.
(amended 2009/05/11)

N525.2 Definitions
(amended 2009/05/11)

(a) Bulk Average Fuel Temperature means the average fuel temperature within the fuel tank or different sections of the tank if the tank is subdivided by baffles or compartments.
(amended 2009/05/11)

(b) Flammability Exposure Evaluation Time (FEET). The time from the start of preparing the aeroplane for flight, through the flight and landing, until all payload is unloaded, and all passengers and crew have disembarked. In the Monte Carlo program, the flight time is randomly selected from the Flight Length Distribution (Table 2), the pre-flight times are provided as a function of the flight time, and the post-flight time is a constant 30 minutes.
(amended 2009/05/11)

(c) Flammable. With respect to a fluid or gas, flammable means susceptible to igniting readily or to exploding. A non-flammable ullage is one where the fuel-air vapour is too lean or too rich to burn or is inert as defined below. For the purposes of this appendix, a fuel tank that is not inert is considered flammable when the bulk average fuel temperature within the tank is within the flammable range for the fuel type being used. For any fuel

tank that is subdivided into sections by baffles or compartments, the tank is considered flammable when the bulk average fuel temperature within any section of the tank, that is not inert, is within the flammable range for the fuel type being used.
(amended 2009/05/11)

(d) Flash Point. The flash point of a flammable fluid means the lowest temperature at which the application of a flame to a heated sample causes the vapour to ignite momentarily, or ‘‘flash.’’ Table 1 of this appendix provides the flash point for the standard fuel to be used in the analysis.
(amended 2009/05/11)

(e) Fleet average flammability exposure is the percentage of the flammability exposure evaluation time (FEET) each fuel tank ullage is flammable for a fleet of an aeroplane type operating over the range of flight lengths in a world-wide range of environmental conditions and fuel properties as defined in this appendix.
(amended 2009/05/11)

(f) Gaussian Distribution is another name for the normal distribution, a symmetrical frequency distribution having a precise mathematical formula relating the mean and standard deviation of the samples. Gaussian distributions yield bell-shaped frequency curves having a preponderance of values around the mean with progressively fewer observations as the curve extends outward.
(amended 2009/05/11)

(g) Hazardous atmosphere. An atmosphere that may expose maintenance personnel, passengers or flight crew to the risk of death, incapacitation, impairment of ability to self-rescue (that is, ability to escape unaided from a confined space), injury, or acute illness.
(amended 2009/05/11)

(h) Inert. For the purpose of this appendix, the tank is considered inert when the bulk average oxygen concentration within each compartment of the tank is 12 percent or less from sea level up to 10,000 feet altitude, then linearly increasing from 12 percent at 10,000 feet to 14.5 percent at 40,000 feet altitude, and extrapolated linearly above that altitude.
(amended 2009/05/11)

(i) Inerting. A process where a non-combustible gas is introduced into the ullage of a fuel tank so that the ullage becomes non-flammable.
(amended 2009/05/11)

(j) Monte Carlo Analysis. The analytical method that is specified in this appendix as the compliance means for assessing the fleet average flammability exposure time for a fuel tank.
(amended 2009/05/11)

(k) Oxygen evolution occurs when oxygen dissolved in the fuel is released into the ullage as the pressure and temperature in the fuel tank are reduced.
(amended 2009/05/11)

(l) Standard deviation is a statistical measure of the dispersion or variation in a distribution, equal to the square root of the arithmetic mean of the squares of the

deviations from the arithmetic means.
(amended 2009/05/11)

(m) Transport Effects. For purposes of this appendix, transport effects are the change in fuel vapor concentration in a fuel tank caused by low fuel conditions and fuel condensation and vaporization.
(amended 2009/05/11)

(n) Ullage. The volume within the fuel tank not occupied by liquid fuel.
(amended 2009/05/11)

N525.3 Fuel Tank Flammability Exposure Analysis
(amended 2009/05/11)

(a) A flammability exposure analysis must be conducted for the fuel tank under evaluation to determine fleet average flammability exposure for the aeroplane and fuel types under evaluation. For fuel tanks that are subdivided by baffles or compartments, an analysis must be performed either for each section of the tank, or for the section of the tank having the highest flammability exposure. Consideration of transport effects is not allowed in the analysis. The analysis must be done in accordance with the methods and procedures set forth in the Fuel Tank Flammability Assessment Method User's Manual, dated May 2008, document number DOT/FAA/AR–05/8. The parameters specified in N525.3(b) and (c) of this appendix must be used in the fuel tank flammability exposure "Monte Carlo" analysis.
(amended 2009/05/11)

(b) The following parameters are defined in the Monte Carlo analysis and provided in N525.4 of this appendix:
(amended 2009/05/11)

(1) Cruise Ambient Temperature, as defined in this appendix.
(amended 2009/05/11)

(2) Ground Ambient Temperature, as defined in this appendix.
(amended 2009/05/11)

(3) Fuel Flash Point, as defined in this appendix.
(amended 2009/05/11)

(4) Flight Length Distribution, as defined in Table 2 of this appendix.
(amended 2009/05/11)

(5) Aeroplane Climb and Descent Profiles, as defined in the Fuel Tank Flammability Assessment Method User's Manual, dated May 2008, document number DOT/FAA/AR–05/8.
(amended 2009/05/11)

(c) Parameters that are specific to the particular aeroplane model under evaluation that must be provided as inputs to the Monte Carlo analysis are:
(amended 2009/05/11)

(1) Aeroplane cruise altitude.
(amended 2009/05/11)

(2) *Fuel tank quantities*. If fuel quantity affects fuel tank flammability, inputs to the Monte Carlo analysis must be provided that represent the actual fuel quantity within the fuel tank or compartment of the fuel tank throughout each of the flights being evaluated. Input values for this data must be obtained from ground and flight test data or the approved fuel management procedures.
(amended 2009/05/11)

(3) Aeroplane cruise mach number.
(amended 2009/05/11)

(4) Aeroplane maximum range.
(amended 2009/05/11)

(5) *Fuel tank thermal characteristics*. If fuel temperature affects fuel tank flammability, inputs to the Monte Carlo analysis must be provided that represent the actual bulk average fuel temperature within the fuel tank at each point in time throughout each of the flights being evaluated. For fuel tanks that are subdivided by baffles or compartments, bulk average fuel temperature inputs must be provided for each section of the tank. Input values for these data must be obtained from ground and flight test data or a thermal model of the tank that has been validated by ground and flight test data.
(amended 2009/05/11)

(6) Maximum aeroplane operating temperature limit, as defined by any limitations in the aeroplane flight manual.
(amended 2009/05/11)

(7) *Aeroplane Utilization*. The applicant must provide data supporting the number of flights per day and the number of hours per flight for the specific aeroplane model under evaluation. If there is no existing aeroplane fleet data to support the aeroplane being evaluated, the applicant must provide substantiation that the number of flights per day and the number of hours per flight for that aeroplane model is consistent with the existing fleet data they propose to use.
(amended 2009/05/11)

(d) Fuel Tank FRM Model. If FRM is used, an approved Monte Carlo program must be used to show compliance with the flammability requirements of 525.981 and Appendix M of this chapter. The program must determine the time periods during each flight phase when the fuel tank or compartment with the FRM would be flammable. The following factors must be considered in establishing these time periods:
(amended 2009/05/11)

(1) Any time periods throughout the flammability exposure evaluation time and under the full range of expected operating conditions, when the FRM is operating properly but fails to maintain a non-flammable fuel tank because of the effects of the fuel tank vent system or other causes;
(amended 2009/05/11)

(2) If dispatch with the system inoperative under the Master Minimum Equipment List (MMEL) is requested, the time period assumed in the reliability analysis (60 flight

hours must be used for a 10-day MMEL dispatch limit unless an alternative period has been approved by the Minister);
(amended 2009/05/11)

(3) Frequency and duration of time periods of FRM inoperability, substantiated by test or analysis acceptable to the Minister, caused by latent or known failures, including aeroplane system shut-downs and failures that could cause the FRM to shut down or become inoperative.
(amended 2009/05/11)

(4) Effects of failures of the FRM that could increase the flammability exposure of the fuel tank.
(amended 2009/05/11)

(5) If an FRM is used that is affected by oxygen concentrations in the fuel tank, the time periods when oxygen evolution from the fuel results in the fuel tank or compartment exceeding the inert level. The applicant must include any times when oxygen evolution from the fuel in the tank or compartment under evaluation would result in a flammable fuel tank. The oxygen evolution rate that must be used is defined in the Fuel Tank Flammability Assessment Method User's Manual, dated May 2008, document number DOT/FAA/AR–05/8.
(amended 2009/05/11)

(6) If an inerting system FRM is used, the effects of any air that may enter the fuel tank following the last flight of the day due to changes in ambient temperature, as defined in Table 4, during a 12-hour overnight period.
(amended 2009/05/11)

(e) The applicant must submit for approval the fuel tank flammability analysis, including the aeroplane-specific parameters identified under N525.3(c) of this appendix and any deviations from the parameters identified in N525.3(b) of this appendix that affect flammability exposure, substantiating data and any airworthiness limitations and other conditions assumed in the analysis.
(amended 2009/05/11)

N525.4 Variables and Data Tables
(amended 2009/05/11)

The following data must be used when conducting a flammability exposure analysis to determine the fleet average flammability exposure. Variables used to calculate fleet flammability exposure must include atmospheric ambient temperatures, flight length, flammability exposure evaluation time, fuel flash point, thermal characteristics of the fuel tank, overnight temperature drop and oxygen evolution from the fuel into the ullage.
(amended 2009/05/11)

(a) Atmospheric Ambient Temperatures and Fuel Properties.
(amended 2009/05/11)

(1) In order to predict flammability exposure during a given flight, the variation of ground ambient temperatures, cruise ambient temperatures and a method to compute the transition from ground to cruise and back again must be used. The variation of the

ground and cruise ambient temperatures and the flash point of the fuel is defined by a Gaussian curve, given by the 50 percent value and a ±1-standard deviation value.
(amended 2009/05/11)

(2) *Ambient Temperature*: Under the program, the ground and cruise ambient temperatures are linked by a set of assumptions on the atmosphere. The temperature varies with altitude following the International Standard Atmosphere (ISA) rate of change from the ground ambient temperature until the cruise temperature for the flight is reached. Above this altitude, the ambient temperature is fixed at the cruise ambient temperature. This results in a variation in the upper atmospheric temperature. For cold days, an inversion is applied up to 10,000 feet, and then the ISA rate of change is used.
(amended 2009/05/11)

(3) Fuel properties:
(amended 2009/05/11)

(i) For Jet A fuel, the variation of flash point of the fuel is defined by a Gaussian curve, given by the 50 percent value and a ±1-standard deviation, as shown in Table 1 of this appendix.
(amended 2009/05/11)

(ii) The flammability envelope of the fuel that must be used for the flammability exposure analysis is a function of the flash point of the fuel selected by the Monte Carlo for a given flight. The flammability envelope for the fuel is defined by the upper flammability limit (UFL) and lower flammability limit (LFL) as follows:
(amended 2009/05/11)

(A) LFL at sea level = flash point temperature of the fuel at sea level minus 10°F. LFL decreases from sea level value with increasing altitude at a rate of 1°F per 808 feet.
(amended 2009/05/11)

(B) UFL at sea level = flash point temperature of the fuel at sea level plus 63.5°F. UFL decreases from the sea level value with increasing altitude at a rate of 1°F per 512 feet.
(amended 2009/05/11)

(4) For each flight analyzed, a separate random number must be generated for each of the three parameters (ground ambient temperature, cruise ambient temperature, and fuel flash point) using the Gaussian distribution defined in Table 1 of this appendix.
(amended 2009/05/11)

Table 1 — Gaussian Distribution for Ground Ambient Temperature, Cruise Ambient Temperature and Fuel Flash Point
(amended 2009/05/11)

Parameter	Temperature in °F		
	Ground ambient temperature	Cruise ambient temperature	Fuel flash point (FP)
Mean Temp	59.95	-70	120
Neg 1 std dev	20.14	8	8
Pos 1 std dev	17.28	8	8

(b) The Flight Length Distribution defined in Table 2 must be used in the Monte Carlo analysis.
(amended 2009/05/11)

Table 2 — Flight Length Distribution
(amended 2009/05/11)

Flight length (NM)		Aeroplane maximum range—nautical miles (NM)									
From	To	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
		Distribution of flight lengths (percentage of total)									
0	200	11.7	7.5	6.2	5.5	4.7	4.0	3.4	3.0	2.6	2.3
200	400	27.3	19.9	17.0	15.2	13.2	11.4	9.7	8.5	7.5	6.7
400	600	46.3	40.0	35.7	32.6	28.5	24.9	21.2	18.7	16.4	14.8
600	800	10.3	11.6	11.0	10.2	9.1	8.0	6.9	6.1	5.4	4.8
800	1000	4.4	8.5	8.6	8.2	7.4	6.6	5.7	5.0	4.5	4.0
1000	1200	0.0	4.8	5.3	5.3	4.8	4.3	3.8	3.3	3.0	2.7
1200	1400	0.0	3.6	4.4	4.5	4.2	3.8	3.3	3.0	2.7	2.4
1400	1600	0.0	2.2	3.3	3.5	3.3	3.1	2.7	2.4	2.2	2.0
1600	1800	0.0	1.2	2.3	2.6	2.5	2.4	2.1	1.9	1.7	1.6
1800	2000	0.0	0.7	2.2	2.6	2.6	2.5	2.2	2.0	1.8	1.7
2000	2200	0.0	0.0	1.6	2.1	2.2	2.1	1.9	1.7	1.6	1.4
2200	2400	0.0	0.0	1.1	1.6	1.7	1.7	1.6	1.4	1.3	1.2
2400	2600	0.0	0.0	0.7	1.2	1.4	1.4	1.3	1.2	1.1	1.0
2600	2800	0.0	0.0	0.4	0.9	1.0	1.1	1.0	0.9	0.9	0.8
2800	3000	0.0	0.0	0.2	0.6	0.7	0.8	0.7	0.7	0.6	0.6
3000	3200	0.0	0.0	0.0	0.6	0.8	0.8	0.8	0.8	0.7	0.7
3200	3400	0.0	0.0	0.0	0.7	1.1	1.2	1.2	1.1	1.1	1.0
3400	3600	0.0	0.0	0.0	0.7	1.3	1.6	1.6	1.5	1.5	1.4
3600	3800	0.0	0.0	0.0	0.9	2.2	2.7	2.8	2.7	2.6	2.5
3800	4000	0.0	0.0	0.0	0.5	2.0	2.6	2.8	2.8	2.7	2.6
4000	4200	0.0	0.0	0.0	0.0	2.1	3.0	3.2	3.3	3.2	3.1
4200	4400	0.0	0.0	0.0	0.0	1.4	2.2	2.5	2.6	2.6	2.5
4400	4600	0.0	0.0	0.0	0.0	1.0	2.0	2.3	2.5	2.5	2.4
4600	4800	0.0	0.0	0.0	0.0	0.6	1.5	1.8	2.0	2.0	2.0
4800	5000	0.0	0.0	0.0	0.0	0.2	1.0	1.4	1.5	1.6	1.5
5000	5200	0.0	0.0	0.0	0.0	0.0	0.8	1.1	1.3	1.3	1.3
5200	5400	0.0	0.0	0.0	0.0	0.0	0.8	1.2	1.5	1.6	1.6

Flight length (NM)		Aeroplane maximum range—nautical miles (NM)									
From	To	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
		Distribution of flight lengths (percentage of total)									
5400	5600	0.0	0.0	0.0	0.0	0.0	0.9	1.7	2.1	2.2	2.3
5600	5800	0.0	0.0	0.0	0.0	0.0	0.6	1.6	2.2	2.4	2.5
5800	6000	0.0	0.0	0.0	0.0	0.0	0.2	1.8	2.4	2.8	2.9
6000	6200	0.0	0.0	0.0	0.0	0.0	0.0	1.7	2.6	3.1	3.3
6200	6400	0.0	0.0	0.0	0.0	0.0	0.0	1.4	2.4	2.9	3.1
6400	6600	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.8	2.2	2.5
6600	6800	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.2	1.6	1.9
6800	7000	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8	1.1	1.3
7000	7200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.7	0.8
7200	7400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.7
7400	7600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.6
7600	7800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.7
7800	8000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	0.8
8000	8200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.8
8200	8400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0
8400	8600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.3
8600	8800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.1
8800	9000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8
9000	9200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
9200	9400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
9400	9400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9600	9600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9800	9800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

(c) Overnight Temperature Drop. For aeroplanes on which FRM is installed, the overnight temperature drop for this appendix is defined using:
(amended 2009/05/11)

(1) A temperature at the beginning of the overnight period that equals the landing temperature of the previous flight that is a random value based on a Gaussian distribution; and
(amended 2009/05/11)

(2) An overnight temperature drop that is a random value based on a Gaussian distribution.
(amended 2009/05/11)

(3) For any flight that will end with an overnight ground period (one flight per day out of an average number of flights per day, depending on utilization of the particular aeroplane model being evaluated), the landing outside air temperature (OAT) is to be chosen as a random value from the following Gaussian curve:
(amended 2009/05/11)

Table 3 — Landing Outside Air Temperature
(amended 2009/05/11)

Parameter	Landing outside air temperature °F
Mean Temperature	58.68
negative 1 std dev	20.55
positive 1 std dev	13.21

(4) The outside ambient air temperature (OAT) overnight temperature drop is to be chosen as a random value from the following Gaussian curve:

Table 4 —Outside Air Temperature (OAT) Drop
(amended 2009/05/11)

Parameter	OAT drop temperature °F
Mean Temperature	12.0
1 std dev	6.0

(d) Number of Simulated Flights Required in Analysis. In order for the Monte Carlo analysis to be valid for showing compliance with the fleet average and warm day flammability exposure requirements, the applicant must run the analysis for a minimum number of flights to ensure that the fleet average and warm day flammability exposure for the fuel tank under evaluation meets the applicable flammability limits defined in Table 5 of this appendix.
(amended 2009/05/11)

Table 5 —Flammability Exposure Limit
(amended 2009/05/11)

Minimum number of flights in Monte Carlo analysis	Maximum acceptable Monte Carlo average fuel tank flammability exposure (percent) to meet 3 percent requirements	Maximum acceptable Monte Carlo average fuel tank flammability exposure (percent) to meet 7 percent requirements
10,000	2.91	6.79
100,000	2.98	6.96
1,000,000	3.00	7.00